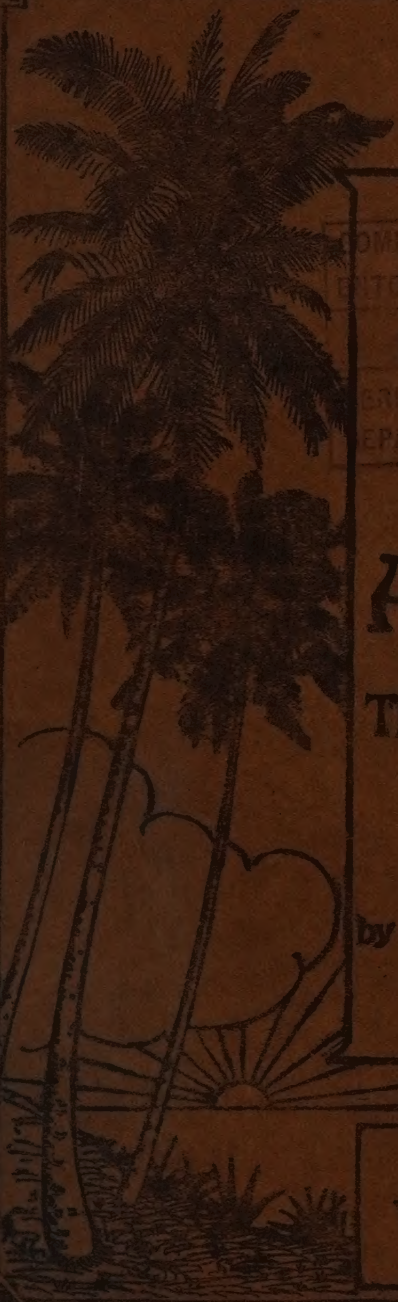
Registered as a Newspaper in Ceylon



VOL. CV. No. 1
JANUARY TO MARCH, 1949
(1st QUARTER, 1949)

22 As.3

The Tropical Agriculturist

The Agricultural Journal of Ceylon

Founded in 1881
by the late Mr. JOHN FERGUSON, C.M.G.

Published by
The Department of Agriculture
Peradeniya, Ceylon.

Department of Agriculture–Ceylon

ORGANIZATION

Director of Agriculture and Editor, Tropical Agriculturist

D. Rhind, O.B.E., B.Sc., F.L.S.

Deputy Directors

A. W. R. Joachim, M.B.E., Ph.D., B.Sc. (Lond.) Dip. Agric. (Cantab.), F.I.C., Deputy Director of Agriculture, Peradeniya. (On leave.)

C. N. E. J. de Mel, B.Sc. (Hons.), B.Sc. Agric. (Lond.), Dip. Agric. (Wye), Acting Deputy Director of Agriculture, Peradeniya.

T. M. Z. Mahamooth, M.R.V.C.S. (Edin.), G.B.V.C., Deputy Director, Animal Husbandry, and Government Veterinary Surgeon, Peradeniya. (Study leave.)

P. G. Malkani, B.A. (Hons.) Botany, B.Sc. (Lond.), Vet. M.R.V.C.S., Specialist in Animal Husbandry (Diseases), and Acting Deputy Director Animal Husbandry, and Government Veterinary Surgeon, Peradeniya

Administrative Staff

H. E. S. Ranasinghe, Ceylon Civil Service, Administrative Secretary, Department of Agriculture, Peradeniya.

S. M. Kanagaratnam, Accountant, Department of Agriculture, Peradeniya.

Agricultural Education

W. R. C. Paul, M.A., Dip. Agric. (Cantab.), Ph.D. M.Sc., (Lond.), D.I.C., A.I.C.T.A. (Trinidad), Acting Principal, School of Agriculture, Peradeniya

Miss E. H. Crowther, B.Sc. (Reading), Principal, Girls' Farm School, Kundasale.

Head Quarters Research Officers

Botany

M. F. Chandraratne, Ph.D., B.Sc., (Lond.), D.I.C., Botanist and Senior Agricultural Research Officer, Peradeniya.

Entomology

B. A. Baptist, Ph.D. (Cantab.), B.Sc. (Lond), Entomologist, Peradeniya.

Horticulture

A. V. Richards, M.Sc. (Calif.) B.Sc. (Lond.) Dip. Agric. (Cantab.), A.I.C.T.A. (Trinidad), Horticultural Officer, Peradeniya.

Chemistry

D. E. V. Koch, Ph.D., B.Sc., (Lond.), F.R.I.C., D.I.C., Chemist, Peradeniya

S. Kandiah, Dip. Agric. (Poona), Chemical Assistant for Soil Surveys, Peradeniya.

Pathology

J. W. L. Pieris, B.Sc., Ph.D. (Lond.), D.I.C., Plant Pathologist, Peradeniya

L. S. Bertus, Asst. Plant Pathologist, Peradeniya

Botanical Gardens

D. M. A. Jayaweera, M.Sc., F.L.S., Superintendent, Botanical Gardens, Peradeniya.

Divisional Agricultural Officers

H. A. Pieris, B.A. (Cantab.), A.I.C.T.A. (Trinidad), Agricultural Officer, South Eastern Division, Tangalla.

S. K. Thuraisingham, B.Sc. (Lond.), Dip. Agric. (Wye), Agricultural Officer, Northern Division.

C. R. Karunaratne, Dip. Agric. (Wye), Dip. Agric. (Poona) Agricultural Officer, North-Central Division, Anuradhapura

R. E. Ponniah, B.Sc. (Edin.), Dip. Agric. (Poona), Agricultural Officer, North-Western Division, Wariyapola.

A. L. Johnpulle, B.Sc. (Lond.) F.E.S., A.I.C.T.A. (Trinidad), Agricultural Officer, South Central Division, Bandarawela.

P. T. Jinendradasa, B.Sc. (Lond.), Agricultural Officer, South-Western Division, Horana.

S. Kanagaratnam, B.Sc. (Lond.), B.Ag. (Bombay), Agricultural Officer, Eastern Division, Batticaloa

M. L. C. Illangakoon, B.Sc. (Lond.), Agricultural Officer, Central Division, Peradeniya.

E. W Bandaranaike, Dip. Agric. (Poona), Asst. Agricultural Officer, South-Eastern Division, Tangalla.

S. C. Gunaratnam, B.A. Madras, Asst. Agricultural Officer, North-Central Division, Anuradhapura.

I——J. N .A 90680 (8/49)

Agricultural Research Officers

G. V. Wickremasinhe, A.I.C.T.A. (Trinidad), Dip. Agric. (Poona), Research Officer, Ratalagala.

L. H. Fernando, B.Sc. (Lond.), Research Officer, Bandarawela.

D. V. Arjunarajah, B.Sc. (Lond.), Research Officer, Bandarawela.

E. F. L. Abeyratne, B.Sc. (Lond.), Research Officer, Maha Illuppallama.

Tobacco

A. B. Attygalle, Tobacco Officer, Peradeniya.

Agronomy

E. S. de S. Jayasundera, Dip. Agric. (Poona), Agronomic Assistant and Agricultural Officer, Maha Illuppallama.

Agricultural Engineers

D. W. Bastiampillai, B.Sc. (Engineering) (Lond.), England, A.M.I.C.E., A.M.I.Mech. E., A.M.I.E.E., A.M.I.A.E., A.F.R. Ac.S., W.S.A.E. U.S.A., M.A.S.A.E., M.I.S.A.E., Engineer.

Propaganda Officers

S. B. Tennekoon, Propaganda Officer, Peradeniya.

G. de Silva, Asst. Propaganda Officer, Anuradhapura.

A. W. Kannangara, Asst. Propaganda Officer, Hiruna.

M. R. M. Jayaratnam, Asst. Propaganda Officer, Bandarawela.

The

Tropical Agriculturist

Vol. CV. PERADENIYA, JANUARY–MARCH, 1949 No. 1

Page

Editorial: Agriculture and Population Density 1

ORIGINAL ARTICLES

Roving Agriculture and the Problem of Dry Farming by Dr. W. R. C. Paul, Principal, School of Agriculture, Peradeniya.. 4

Eradication and Control of Rinderpest in Ceylon by Mr. T. M. Z. Mahamoodh, Deputy Director (Animal Husbandry) and Government Veterinary Surgeon, Peradeniya .. 14

DEPARTMENTAL NOTES

Mixed Farming by C. R. Turbet 22

Some notes on the Cultivation of Cabbage by J. J. Niles, Agricultural Instructor .. 26

REVIEWS

Book Review 29

SELECTED ARTICLES

Utilisation of Phosphatic Fertilisers by Plants, after their absorption into the soil, by G. Barbier, B. Chabannes and A. Marquis, Central Station of Agronomy, Versailles.. 30

MEETINGS, CONFERENCES, &c.

Minutes of the 98th Meeting of the Board of Management, Coconut Research Scheme.. 34

Minutes of the 91st Meeting of the Rubber Research Board 36

RETURNS

Animal Disease Returns, January, February, and March, 1949 39

Meteorological Reports, January, February, and March, 1949 42

The

Tropical Agriculturist

JANUARY TO MARCH, 1949

EDITORIAL

Agriculture and Population Density

IN Ceylon the distribution of the rural population is very uneven and the unevenness is intensified if the urban population is considered as well. The rural population tends to congregate in areas where climatic and soil factors are favourable to agriculture, whether of permanent plantation crops or of paddy. Thus we find that in the coastal districts and in the wet zone the percentage of the land cropped is relatively high and the population dense compared to the dry zone. Further, this concentration of population leads to a reduction in size of holdings (apart from large estates) to an extent more evident than in the dry zone.

It has been frequently observed that the greater the density of the population the greater the care bestowed on the cultivation of the land. This is noticeable in Ceylon where the cultivation is generally of a higher standard in the wet zone compared to the dry zone, though even so it leaves much to be desired. The utilization of the land in the denser-populated wet zone is much more intense. The bunding of every available piece of land for rice cultivation and the planting of the hilly parts with permanent crops such as rubber, cinnamon, citronella, tea and mixed gardens is a characteristic of this zone. Doubtless this is because the denser population demands a greater production of food and of saleable products. A second and most important difference is the almost complete absence of shifting cultivation (*chena*) in the densely populated areas whereas in the dry zone it is the prevailing system apart from rice in low-lying hollows or where irrigation is possible. The *chena* system cannot by its very nature sustain a high population. A minimum interval between successive fellings of the forest is essential and in consequence a greater area of land is required to sustain an individual than is the case under sedentary agriculture. Under shifting cultivation the fallow area is very large and may amount to ten or more times the cultivated area. Yields are also generally low. Repeated fellings and a contraction of the time interval allowed for regeneration causes deterioration in the forest,

less accumulation of humus and a poorer burn in each successive cycle. Ultimately the land becomes unprofitable for shifting cultivation and one of two things must happen. Either the population migrates to new areas, as has often happened in the hinterland of Asia, or the people are compelled to adopt sedentary agriculture and to change their methods entirely. A similar result can come from repeated invasion of the *chena* by fire, which destroys young trees while allowing coarse grasses to persist. In such ways *patna* lands and savannahs are formed. There is no doubt that the deterioration of the forests through a shortening of the *chena* cycle has led to the downfall of many races in the past and it is a probable cause of the abandonment of much of the dry zone lands of Ceylon. If there had been a system of sedentary agriculture a higher population could have maintained itself, but once the population density rose to a point where forest regeneration was hindered the break-down of the *chena* system became inevitable. The people then seem to have adopted the first alternative and to have migrated.

As a system suited to the needs of primitive peoples there is much to recommend *chena* cultivation, but it is limited in the population it can support and, as the people become settled in permanent centres of residence and as their demands for social services rise, the system breaks down. It is not, however, to be wholly condemned under certain conditions and it may be justified if a long enough cycle can be maintained. It is doubtful whether this can be done any longer in the drier parts of Ceylon and, perhaps for the second time in history, an alternative must be found. With no land to migrate to, the adoption of permanent rotational agriculture would seem to be the only way out. Van Beukering has estimated that so long as the population does not exceed 130 per square mile the forests of Java can regenerate under *chena* cropping, but it is certain that the Ceylon dry forests will not be replenished so rapidly. The density of population in Ceylon's dry zone, as given by Paul in his paper in this issue, is 81 per square mile, which we are inclined to think indicates that the limit of curtailment of the *chena* cycle has been reached, even allowing for the proportion of permanent rice lands. The adoption of methods of rapid regeneration of abandoned *chenas* by planting quick-growing trees and shrubs to permit a shorter rotation period may stave off for a time the change-over to another system but cannot be a permanent remedy in the face of a rising population. It is but a step in the direction of a permanent agriculture. The system of mixed farming advocated by Turbet in this number represents a gradual evolution from shifting methods to a static form of agriculture. With permanent villages and garden culture already established there has been a slow, gradual evolution towards a stable form of land usage.

We would like to direct attention to garden culture since this is a characteristic of most villages of Ceylon and the present policy of settlement on the land envisages its continuance on the highland part of each holding. A stroll round any village, particularly in the wetter areas, reveals a very large variety of fruit trees and crops, not required in large amount, but which supplement and add attraction to the rice meal. Some Dutch workers regard this varied garden culture as a remnant of a primitive hoe culture, the useful plants of the forests having been collected together near the dwellings. The area

occupied by such mixed gardens in Ceylon must be very large but there has been no detailed study of its production or improvement. It is not possible to say how many calories the villager derives from his garden land. The value of garden culture is undoubtedly great, particularly from the nutritional point of view, while saleable produce improves the villager's economy. The unbalance of the economy of peoples who depend solely on one crop, as occurs in large parts of Asia such as parts of Siam and Burma, is very evident, and this is intensified where the land tenure system leads to a class of roving tenants with no interest in a permanent garden.

The inter-relationships of the many species involved in garden culture must constitute a very complex community in which any disturbance of the balance would be risky. Any attempts at improvement should be cautious and the mixture of species planted in seeming disorder should not be viewed against the Western background of well-ordered orchards and plantations. The serious erosion of clean-weeded, line-planted crops is not so noticeable in the garden culture, which receives far less attention and disturbance, and where the mixture of plants seem to have settled almost into a climax community.

Roving Agriculture and the Problem of Dry Farming

BY

W. R. C. PAUL

PERADENIYA

AGRICULTURE in Ceylon is mainly based on a plantation economy in which tea, rubber and coconuts form about 90 per cent. of the total export trade and occupy about 60 per cent. of the cultivated land. Paddy is the staple food crop which is grown on about 912,000 acres amounting to about 25 per cent. of the cultivated area. It is produced throughout the Island in the valleys of the wet zone mainly under rain-fed conditions and in the dry lowlands under irrigation from channels leading from storage reservoirs or tanks. Local production is however inadequate to meet the requirements of the population which has now reached a total of nearly 7 millions and large-scale imports of rice had to be resorted to in the past from Burma, Indo-China, Siam and India. At the present time imports from surplus producing countries are allowed on allocations provided by the International Emergency Food Committee of the Council of the Food and Agricultural Organization at Washington. Other food crops—dry grains, pulses and roots—are grown to a limited extent to supplement the production of paddy. In the wet zone, roots such as sweet potatoes, manioc, Dioscorea yams and the large-leaved yams (*Colocasia antiquorum* Schott. and *Xanthosoma sagittaefolium* (Linn.) Schott.) are grown in the small holdings or mixed gardens. The cereals and pulses are produced mainly under a system of roving agriculture or shifting cultivation as it is more commonly called, except in the Jaffna peninsula where small-scale farming is practised with lift irrigation from underground sources of water.

The two main climatic divisions are the wet zone covering an area of about 4 million acres situated in the centre and south-west part, and the dry zone comprising the northern and eastern portion of the Island with about 12 million acres. The wet zone is subject to the influence of two monsoonal periods of rain, the north-east which reaches its peak in November and the south-west in May. The total rainfall is zonally distributed and varies from 75–160 in. The land rises in 3 peneplains, the first from sea level to about 500 feet, the second from 1,500 to 2,000 feet, and the third from 3,000 to 5,000 feet. The soils are typical laterite or lateritic loams derived from archean rocks. About 50 per cent. of the total cultivated land of about 3½ million acres occurs in this zone. The permanent economic crops—tea, rubber, coconuts, cacao, citronella and cinnamon—are almost entirely grown in this zone except for coconuts which extend along the coastal sandy belts of the north-western and eastern sides of the island. These crops, with paddy in the valleys and numerous small holdings of the mixed garden type, leave little

land for further cultivation, except on the steeps. Some hill slopes were cleared for shifting cultivation in which *kurakkan* (*Eleusine indica* Gaertn.) and kodo millet (*Paspalum scorbiculatum* Linn.) were the chief crops, but with the increasing scarcity of land in this zone the practice has almost ceased. The forests that now clothe the hills are on slopes which are too steep for clearing and indeed from the point of view of the prevention of flooding and erosion should no more be alienated, especially in the catchment areas of rivers and streams. Further deforestation in the wet zone except in prescribed areas should also be prevented from considerations of climate and the maintenance of the agri-forest balance.

In the dry lowlands which extend over the greater part of the Island, the annual rainfall is about 40–75 in. most of which is precipitated with the north-east monsoon, the total rainfall for the south-west monsoon (May to September) being less than 20 in. This zone where the natural vegetation is different lies mainly within the first peneplain. The soil is lateritic or a non-lateritic loam of fair depth, rich in humus and mineral nutrients. The northern end, however, is characterized by sedimentary miocene limestone and the north-west portion by pleistocene sands. The natural vegetation is medium and high jungle, present in abundance due to a low density of population (81 persons per square mile as compared with 596 persons per square mile in the wet zone). With the exception of the limestone area in the north there are no underground sources of water and therefore surface irrigation from intermittent supplies carried by the main rivers and conserved in an extensive network of tanks was resorted to. Paddy was given first consideration and all irrigation schemes were designed for this crop. In order to augment the supply of paddy which was limited by the number and extent of the available irrigation schemes and was insufficient for the average peasant's requirements, other food crops were raised on a system of roving agriculture or shifting cultivation. This is a wide-spread practice in parts of tropical America, Africa and South-East Asia where it is known by various local names such as *canues* in South America, *chena* in Ceylon, *kumri* in southern and western India, *jhum* in central and north-east India, *khoria* in Nepal, *taungya* in Burma, *tam rai* in Siam, *ray* in Indo-China, and *caingin* in the Philippines. The practice in essence is the same in these countries and in brief relates to the cutting down and burning of virgin and secondary forest, and to a lesser extent burning grass, for the cultivation mainly of food crops—dry grains, pulses and vegetables—for a few seasons ; and as soon as the land shows signs of exhaustion the cultivator abandons it and clears a fresh patch of forest or grass.

In order to control the rate of destruction of the forests in Ceylon, areas for *chenas* were zoned and permits were issued by Revenue Officers on the basis of an acre per family for raising food crops. When cotton was introduced as a commercial crop for the dry zone, separate permits were also issued for clearing land for growing this crop. The period of cropping extends over 2 to 3 seasons or 1 to 1½ years. The clearing is done by felling and burning the jungle during July and August. The land is planted in October and November with the north-east monsoon rains, with a mixture of *kurakkan*, maize, green gram (*Phaseolus aureus* Roxb.) mustard, amaranthus and chilli (*Capsicum annuum* Linn.) with some Italian millet (*Setaria italica* Beauv.)

and Panicum millet (*Panicum miliaceum* Linn.), the chief crop in the mixture being kurakkan. After the harvest of these crops in January cattle are allowed to enter the *chena* for a brief spell to eat down the stubble, and the land is tilled with hoes in preparation for sowing quick-maturing crops such as green gram and gingelly (*Sesamum orientale* Linn.) for the restricted south-west monsoon rains in April and May. The chilli plants which were eaten down by the cattle produce fresh growth and after the harvest of the green gram and gingelly the ripe fruits are picked on 2 or 3 occasions and dried. Clearing is done once more with hoes in September and October and *kurakkan* and other grains are sown for the 3rd season with the north-east monsoon rains after which the land is abandoned. In other countries, e.g., French Indo-China where high forest is cleared, cropping over a period of 4 to 5 years continues. The reasons for the abandonment, of the land subject to this system are (1) weeds which increase in intensity with each successive season's crops, (2) loss of fertility through soil erosion, (3) stump re-growth.

Where the population is sparse and the forests extensive, the practice can generally be continued without any serious ill effects to the land, though in countries like Indo-China where there are vast areas of land available for roving agriculture the long period of cultivation (4 to 5 years) is reported to kill the roots of trees and then weeds such as *Imperata cylindrica* Beauv. and *Eupatorium* sp. invade the area. With a rising population and an increasing demand for forest land, the intervals of rest become necessarily shorter and the regeneration of the forest slower. As the fertility declines competition from pernicious weeds which invade the land becomes more serious. The period between successive clearings is generally 15 to 20 years depending on the height and density of the re-growth, but in many areas it is reduced to 8 to 10 years as jungle, not too remote from villages, becomes scarce and the demand increases. Where repeated clearings after insufficient rest periods have taken place as in parts of the Eastern Province, the climatic climax (forest) has receded to scrub and grass associations in which *Lantana aculeata* Linn., and *Imperata cylindrica* Beauv. (*Illuk*) are dominant species.

In certain countries such as Siam and Indo-China, where roving agriculture is practised, there are two forms (1) on the hills by primitive and nomadic tribes (2) on the lowlands by a settled peasant population. In the case of the former, the tribes are entirely dependent on the crops raised by them while on the lowlands the system is used by the peasants to supplement their crops of irrigated paddy. The *chena* cultivator of Ceylon belongs to the second category. When land which is cleared on the hills is abandoned, the tribes do not later return to it but penetrate further and further into the forests which they progressively destroy.

Shifting cultivation in both its forms is a type of subsistence agriculture and its pernicious effects can hardly be exaggerated. From a forest point of view it is wasteful destruction ; from an agricultural point of view a dissipation of misguided effort ; and from a wider national point of view it leads to a class of land-starved peasantry. The question then arises, as was posed at the last Forestry and Timber Utilization Conference for Asia and the Pacific, organized by the Food and Agriculture Organization of the United Nations and held at Mysore in March–April, 1949, as to why such a destructive system of land use should persist in the face of clear evidence that the end must ultimately be disastrous to the peoples that depend on the land for life.

It has been described as wasteful because of the indiscriminate destruction of the forest without proper exploitation of its resources and the lack of effort to reforest the land with commercially valuable species. As already stated, the land tends to decline in fertility if the period of cropping is unduly prolonged or the intervals of rest between successive periods of cropping are shortened. With the invasion of pernicious weeds, areas are reduced to wastes and become liable to serious erosion. With the recession of the climatic climax from forest to scrub or grass there is a consequent adverse effect on the average climate of the area.

Agriculturally, the system is primitive because the yields are poor, the unit cropped too small, the labour expended too high, and the fertility of the soil neglected. The yields are poor because (*a*) broadcast sowing is practised as against drilling or dibbling, (*b*) after cultivations are often delayed as they are performed by hand labour during a short growing season, (*c*) space is lost by the roots of unstumped trees that are inevitably left in clearing, (*d*) absence of manuring especially of the quick-acting soluble fertilizers after the first season's cropping. The unit cropped (1–2 acres in Ceylon) is too small to provide the peasant with a reasonable standard of living even though it is a supplement to his paddy which itself is limited to a few acres at the most. With his resources and also the tools at his disposal—the axe and the hoe (mamoty)—he is not able to clear, plant and maintain more land. Much labour is involved in felling, burning and clearing the forest, and in erecting a stockade along the boundaries, as well as in the hand-tilling operations. This work has necessarily to be undertaken by co-operative effort. Considerable energy is required in watching the crops at night and in protecting them against the depredations of wild animals from the surrounding forest. All this requires a greater expenditure of effort and energy by the peasant than in settled agriculture. The practice cannot therefore be regarded as due to any indolence on his part.

There is unfortunately no traditional class of peasant farmers in Ceylon —those who live on their holdings and practise a system of mixed farming by raising both arable crops in rotation and livestock. The dry zone peasants have been accustomed to live in small settlements (Singh. *gangoda*) which form the units of villages situated away from his paddy field and *chena*, until colonization schemes under major irrigation works were introduced when a peasant was provided with an allotment of 3 acres and in proximity to it 5 acres of irrigable land for paddy. Such schemes are, however, limited on account of the scarcity of irrigable land and they cannot be expected to provide for the requirements of all dry zone peasants. The system of roving agriculture then persists partly due to the inertia of traditional land use practices which are difficult to break, but essentially because it is dictated by economic necessity. From time immemorial, the peasant has been familiar with two systems of agriculture—the *chena* for dry grains and vegetables, and irrigated paddy fields for his staple food. His limited resources, the comparatively inhospitable nature of his environment, the absence of an assured water supply, are some of the factors which have retarded or prevented the transition to other forms of agriculture.

Roving agriculture, therefore, is born of necessity, and as such it cannot be outlawed overnight by fiats. The only permanent solution is the provision of more attractive forms of settled agriculture, by large-scale colonization under irrigation works—major and minor; and the introduction of dry

farming of arable crops in rotation under a system of alternate husbandry with pasture and fodder—or in other words " a rotation of crops instead of a rotation of land ". These are long-term measures, where progress will necessarily be slow—particularly since large-scale colonization involves a heavy outlay of capital expenditure. What is more urgent is the provision of immediate measures that will minimize or counteract the adverse results of this practice.

This subject was considered by the Forestry and Timber Utilization Conference to which reference has already been made, and the following facts were established (7) :—

(1) " The prevalence of the widespread practice of roving agriculture by both nomadic and settled populations in the countries of this region results in very low standards of living.

(2) The effects of this practice are pernicious and result in the economic loss of forests, the destruction of soil, and the silting up of water courses situated below the cleared areas.

(3) The increasing demand for fresh forest land for roving agriculture as the result of a growing population necessitates some form of restriction to prevent destruction of forests.

(4) The ultimate solution of the problem depends on a broad-based policy which embraces the fields of forestry, agriculture, and social welfare.

The recommendations then made were that the menace of roving agriculture be brought to the notice of Governments concerned, and that the practice be urgently and carefully regulated by the gradual introduction of :

(*a*) " a planned system of reforestation by agri-silvicultural methods ;

(*b*) systems of permanent agriculture, involving the cultivation of paddy in irrigable areas or dry farming of arable crops in rotation with pasture and fodder under a system of alternate husbandry ; and

(*c*) the planting of permanent economic crops.

Provided that in all cases steps are taken to adopt the necessary soil conservation measures."

In the case more especially of the nomadic tribes who in some of the south-east Asian countries practise roving agriculture on the hills and are entirely dependent on this system for their sustenance, the *taungya* or the Burmese form of roving agriculture may be adopted. Briefly, under the *taungya*, the land is planted up, principally in teak, by the peasant, *pari passu* with the cultivation of food crops—and with help and assistance from, and under the supervision of the Forest Department. Indeed the Forest Department relies on this system for the replanting of its teak forests (1). The chief merits of this system are that it not only neutralizes the wasteful aspects of the practice but actually converts it to a practical and useful means whereby to reforest the land with commercially valuable species.

It is a question for the consideration of each country where roving agriculture exists even on the plains as to what extent a similar form can be adopted or adapted to suit local conditions. Reforestation in more valuable timber species is particularly desirable where high forest is being destroyed and

regeneration of poor species takes place after the land has been cropped and abandoned.

In Ceylon, there is an excess of forest in the dry lowlands largely because the component species are of little economic value—they can be computed at about 2 trees per acre of the more valuable species. There are also areas where *Lantana aculeata* Linn. and particularly *Imperata cylindrica* Beauv. (*Illuk*) come in quickly after the forest is cleared. The reforestation of economic species in some of the areas where roving agriculture is practised and especially those which are liable to be invaded by pernicious weeds is desirable. The Forest Department has recently introduced a scheme of co-operative reforestation with teak and *halmilla* (*Berrya cordifolia* Burret.). These are to be planted by the peasant along with their *chena* crops. The financial assistance given is as follows:—Provided the stocking of teak and *halmilla* is over 75 per cent. and the average height of the trees over 4 feet at the end of the first growing season, a sum of Rs. 5 is paid. At the end of the second year a further payment of Rs. 5 is made, and after the 3rd year if the stocking is still over 75 per cent. a sum of Rs. 7·50 is given, making a total of Rs. 17·50 over a period of 3 years. Furthermore, in order to induce the peasant to extend his interest on the land he is permitted to grow plantains on his *chena* at a distance of 40 feet apart and in this way protection is afforded the young teak and *halmilla* plants for a longer period. In the Philippines, *Leucaena glauca* Benth. has been found useful as a nurse crop for planting economically valuable forest trees, the *Leucaena* being periodically lopped until the desired trees rise above it and in this way it has been found to choke out completely all weeds, to double the nitrogen content of the soil, and to improve its physical condition (6). It is sown on a *caingin* (*chena*) after the harvest of an annual crop.

Where the available forest area is restricted and the pressure for land for roving agriculture increasing, resulting in shorter intervals of rest between successive clearings, the planting of quick-growing species in place of natural regeneration may be considered. The factor which determines the rest interval is the rate of growth of the canopy of vegetation. It has been found (3) in Ceylon that 8–10 years is an adequate rest interval in most parts from the standpoint of weed control and the supply of a sufficiency of mineral nutrients from the vegetation. In Indo-China the normal rest interval is 10 years, but it was stated by the French delegate representing Indo-China at the Forestry Conference already referred to that this could be reduced to 5 or 6 years by the introduction of such quick-growing legumes as *Indigofera teysmanii* Miq. and *Leucaena glauca* Benth. (2). These species should be sown at the same time as the last crop and when they reach the height of the crop they should be lopped. This step would help to increase the girth of the legumes before the land is abandoned. It was stated that the planting of such legumes so improved the fertility of the soil that higher yields of annual crops sown could be obtained. *Indigofera teysmanii* Miq. has not been tried before in Ceylon, but *Leucaena glauca* Benth. grows well and is drought-resistant though it is slow at the start. Some years ago trials were made in Ceylon with quick-growing trees such as *Gliricidia sepium* (Jacq.) Steud. and the cashew with the object of reducing the interval between successive clearings on *chenas*, and more recently by R. H. de Mel in the Kurunegala District with *Gliricidia sepium* planted 10 feet by 10 feet the purpose being

to lop the *Gliricidia* every 4 years and then to take a crop of *kurakkan*. Good results are reported by him on 150 acres by this method, which does not involve any burning, weed growth being checked by the close stand of the *Gliricidia* and fertility being restored by the periodic leaf fall, the loppings and the nodules on the roots as well as the shade. Investigations on quick-growing species which would help to restore the fertility of lands subject to roving agriculture in a shorter time both by this method as well as the burning of quick-growing species should also be undertaken along with trials with stock proof live hedges and wind belts.

From the standpoint of the peasant, the most satisfactory method would be the introduction of a system of permanent agriculture, though preference would always be claimed by him for irrigable land for growing paddy. For this purpose, there are two schemes :

(*a*) Colonization under major irrigation works on allotments each consisting of a unit of 5 acres paddy and 3 acres high land.

(*b*) Development of the maximum irrigable extents under village irrigation works.

But as already stated sufficient irrigable areas are not available for providing the requirements of all dry zone peasants and systems of dry farming would appear to be the main method of developing the extensive areas in the dry zone as suggested several years ago by Stockdale (5). There are however, some complex problems on the agronomy of the dry zone that require solution before dry farming can be confidently recommended to the peasant as a more efficient substitute for his system of roving agriculture, the chief of which are (1) erosion and water-logging of the soil in the wet season, (2) erosion and loss of moisture during the dry season, (3) maintenance of structure and the nutrient status of the soil.

The north-east monsoon rains which commence about mid-October give little time for the preparation of the soil, and in November the rainfall is so heavy that the soil soon becomes water-logged especially in the areas between contour bunds. Excess moisture must be drained away quickly but without the removal of soil particles. After the harvest of the north-east monsoon crops in January and February, the land has to be prepared again as quickly as possible for the early maturing south-west monsoon crops (2–3 months). When these crops are over in June, by which time the rains have ceased, there is a prolonged period of dry weather until the advent of the north-east monsoon rains again in October. The soil becomes too hard to be worked after June but even if cultivation is possible with a disc harrow it is undesirable, for it will cause destruction of crumb structure. Again, if all vegetation is removed by cultivation methods and the soil exposed, organic matter tends to get lost and, with the strong winds that prevail during this period, wind erosion takes place. But if the soil is not worked, weeds flourish and set seed and when the north-east monsoon rains arrive weed growth becomes so prolific that their control presents one of the most difficult problems to the peasant. What is required therefore is a crop which will cover the soil uniformly and completely during the dry season so as to protect it from (*a*) wind erosion, (*b*) loss of organic matter, (*c*) loss of crumb structure. The establishment of a short-term grass ley planted towards the end of March

or early April with the rains would appear to be most desirable from this point of view, and if it could be under-sown with a nurse crop of the usual short-term south-west monsoon crops such as gingelly or green gram, the general rotational scheme of cropping for dry zone farming could be maintained. The search for suitable grass and legume components of a pasture is necessary, but it may be difficult to find grasses which could grow and withstand grazing during the prolonged dry spell from June to October. There is however the possibility that if grazing is withheld altogether during this period that the grasses may cover the soil but show no active growth. As regards pasture legumes, *Stylosanthes gracilis* H. B. and K. can be recommended as it has so far proved to be the most drought-resistant of pasture legumes tested in Ceylon. Another alternative is to establish a cover of a drought-resistant legume only, such as *Stylosanthes* referred to above or *Tephrosia purpurea* Pers. though the latter lacks forage value. This legume has been found to be valuable as an alternative crop to paddy in the dry season (4). It has the great advantage of being self-sown once it is introduced into an area. The seed remains dormant while the paddy is growing and after the harvest of the paddy, germinates and covers the ground during the dry season. The plants are turned in when preparatory tillage commences for the next season's paddy crop by which time the seed is shed in the soil. This legume may be tried on unirrigated arable land with and without the sowing of the usual south-west monsoon crops. *Tephrosia* is a deep-rooted crop and it will help in the opening up of the lower layers of the soil. If a good cover either of pasture or a quick growing drought-resistant legume can be maintained during the months of June to September then the cultivation of arable crops in rotation should not present much difficulty. The tillage operations for the north-east monsoon planting should be delayed as long as possible until the strong south-west monsoon winds experienced during July to September have ceased but if, on account of the time factor, ploughing has to commence with the inter-monsoonal rains in September then the soil should be left in the rough and when the blowing has dropped harrowing may be undertaken to pulverise the clods.

From the point of view of soil conservation the establishment of broad-based terraces with a graded channel above the ridge to remove excess water and to prevent water-logging is necessary together with contour strip cropping. Strips of pasture or of legumes such as *Stylosanthes gracilis* H. B. & K. or *Tephrosia purpurea* Pers. should be left at intervals on the slope so that they will check and spread the surface run-off and thus reduce erosion. These will also serve as guide lines for ploughing and planting the cultivated areas on the contour. Wind belts are essential and they should be established with different species so planted that they will show an increasing gradation in height from either side towards the middle. Suitable species are *Leucaena glauca* Benth. *Pongamia pinnata* Merr. (=*Pongamia glabra* Vent.), *Melia azedarach* Linn. leading to *Casuarina equisetifolia* Linn. in the middle.

As regards crops in the rotation the following are the most suitable :—

	North-east monsoon	*South-west monsoon*
Cereals	maize, kurakkan	—
Legumes	green gram and cowpea	green gram and cowpea
Cash crops	cotton, chillies	gingelly
Fodder	sorghum	

Different rotations incorporating some or all of the above crops can be adopted but it is necessary that a sufficient dressing of compost should be given together with a dose of fertilizers to at least some of the crops. A suitable rotation utilizing all the crops above can be drawn up as follows :—

Plots	*North-east monsoon*	*South-west monsoon*
1	.. sorghum (for fodder)	.. cowpeas and/or green gram
2	.. kurakkan and/or maize	.. gingelly
3	.. chillies	.. chillies (contd.)
4	.. cotton	.. cotton (contd.)

In the case of the widely spaced crops such as maize, kurakkan, chillies and cotton, polyculture should be practised by growing a legume such as cowpeas or green gram in association with the non-legume. The mixed crops may be grown in alternate rows.

Each plot may be 1½ acres to 2 acres in extent, and in addition, 3 acres should be brought under pasture and fodder.

Finally, there is the question of the establishment of permanent economic crops other than those which are important from the forest point of view. The climatic and other factors which have been referred to above strictly limit the choice of suitable crops in Ceylon. The suggestion was made by the delegate for Siam at the Forestry Conference previously referred to in this paper, that cinchona and tung oil should be planted on terraced hill slopes, but these crops require a cooler climate and a heavier rainfall than prevails in the dry zone areas of Ceylon. Some of the fibre- and gum-producing crops such as *Agave* sp. and *Acacia senegal* have possibilities but export markets with prices should be assured. There is, however, a good market and an increasing demand for kapok and the Java variety can be recommended as a suitable permanent crop. Amongst orchard crops the mango is the most satisfactory especially if grafted varieties such as *karutha colomban*, *neelam* and *willard* are grown. Finally, there is the palmyrah palm which has considerable economic value and should be grown more extensively in the dry zone.

SUMMARY

Roving agriculture is confined in Ceylon to the dry lowlands where the natural vegetation is jungle. It is practised by peasants who adopt this system to supplement their cultivation of irrigated paddy on small extents. The system has been condemed on many grounds, but it is dictated by economic necessity and cannot be outlawed overnight by fiats. It cannot be regarded as in the past as due to any indolence of the peasant for it involves on his part a considerable degree of energy and effort which is not commensurate with the results.

This subject was considered by the recent Forestry and Timber Utilization Conference for Asia and the Pacific, under the organization of the F.A.O. The following three recommendations were made for the gradual replacement of roving agriculture in all countries where it is practised :—

(*a*) A planned system of reforestation by agri-silvicultural methods.

(*b*) Systems of permanent agriculture, involving the cultivation of paddy in irrigable areas or dry farming of arable crops in rotation with pasture and fodder under a system of alternate husbandry.

(*c*) The planting of permanent economic crops.

Provided that in all cases appropriate soil conservation measures are adopted.

It is suggested that where the available forest area is restricted and the pressure for land for roving agriculture increasing, with the result that the intervals of the rest between successive clearings becomes shorter, the planting of suitable quick-growing species should be undertaken in place of natural regeneration. These can be used both for cutting and burning as in the case of the ordinary forest or by periodically lopping the trees and sowing a crop between them. The possibilities of such species as *Indigofera teysmanii* Miq. as used in French Indo-China, *Leucaena glauca* Benth. and *Gliricidia sepium* (Jacq.) Steud. which grow well in Ceylon need investigation along suitable stock proof live hedges and wind belts.

Reforestation in the lines of the *taungya* system in Burma with economically valuable species has now been introduced using teak and *halmilla* (*Berrya cordifolia* Burret.) for the purpose.

Land for irrigated paddy is always in most demand and whenever available such land is given to peasants, but large-scale settlements involve a heavy outlay of capital and as such dry farming as an immediate measure is more to be favoured. There are, however, many complex problems on the agronomy of the dry zone which need solution before dry farming can be introduced on a large scale. The most important of these problems is the establishment of a vegetal cover during the period June to September when protection of the soil against direct sunlight, strong winds and weeds is necessary. What is needed is the selection of a suitable drought-resistant pasture grass and legume which will also help to restore soil fertility.

The establishment of permanent economic crops other than forest species is limited by the climatic and other conditions which prevail in the dry lowlands. Where no irrigation facilities are available, the mango, palmyrah and kapok are the most suitable, but there are possibilities with other fibre and gum-producing crops, provided suitable markets can be obtained.

REFERENCES

1. Blandford, H. R. .. A note on taungya regeneration especially for range officers, Rangoon, 1923
2. Chollet, A. P. .. Roving agriculture in South Asia. Reported speech of French delegate at the International Forestry and Timber Utilization Conference, Mysore, 1949
3. Joachim, A. W. R. and Kandiah, S. The effect of shifting (*chena*) cultivation and subsequent regeneration of vegetation on soil composition and structure. *The Trop. Agriculturist*, No. 1, Vol. CIV, 1948
4. Paul, W. R. C. .. The value of *Tephrosia purpurea* Pers. as a green manure in the dry zone. *The Trop. Agriculturist*, No. 3, Vol. LXXXVII, 1936
5. Stockdale, F. A. .. The *chena* problem and some suggestions for its solution. Nos. 4 and 5, *The Trop. Agriculturist*, Vol. LXVI, 1926
6. — .. Lands of shifting cultivation—in Soil Conservation. F.A.O. Agricultural series No. 4, Food and Agricultural Organizations of the United Nations—Washington, U. S. A.
7. — .. Report of the Forestry and Timber Utilization Conference for Asia and the Pacific. Food and Agriculture Organization of the United Nations. Mysore, India, 1949

2——J. N. A 90680 (8/49)

Eradication and Control of Rinderpest in Ceylon

BY

T. M. Z. MAHAMOOTH, G.B.V.C., M.R.C.V.S.
DEPUTY DIRECTOR (ANIMAL HUSBANDRY) AND GOVERNMENT VETERINARY SURGEON, PERADENIYA

RINDERPEST, the major plague of cattle, needs no introduction. This disease is one of the most destructive epizootics known in the annals of infectious diseases. Wherever it has appeared there have been tremendous losses of cattle, sheep, goats and pigs. In some territories these animals have become almost extinct. The disease is believed to have originated in Asia Minor, and to have spread throughout Central Europe as a result of wars. It later appeared in Russia where it was called Steppe Murraine. From there it spread to Siberia and subsequently infected practically the whole of Asia. The complete eradication of rinderpest was urgent and consequently European governments adopted measures by which it was pressed back to the Far East. The plague spread considerably in Middle Europe for the last time during the Franco-Prussian War (1870–1871) but in the following decade it was completely suppressed, so that since 1881 it has been confined to Russia and Turkey and, more recently, has apparently disappeared even from European Russia.

While rinderpest is prevalent on the mainland of Asia, it has been eradicated from Ceylon, where it involved a tremendous expenditure of money and livestock. This paper records the methods used in the eradication.

INTRODUCTION OF RINDERPEST INTO CEYLON

Ceylon being so close to India, there has always been the risk of becoming infected from cattle imported for slaughter, work and dairy purposes. During the last century cattle have been imported into the Island in several thousands without proper quarantine, and rinderpest broke out now and again. Although the disease was not endemic, yet cases occurred, being lingering remnants of an outbreak originally traceable to imported cattle. After the appointment of the first Government Veterinary Surgeon, steps were taken to reduce the incidence of this disease but it took thirty-nine years (until 1934) for the disease to be finally eradicated. After 10 years of freedom from the disease, the Island again became infected in 1943, when slaughter cattle and goats were imported from India *via* Colombo for the Forces when proper quarantine measures could not be adopted to house the animals and distribute them. A characteristic feature of the 1943 outbreak, which continued up to September, 1946, was that it started in places adjoining

military livestock depots, unlike the previous outbreaks which spread from one province to another. Since there were several foci of infection, control measures were swiftly adopted even when cattle were surreptitiously removed to various parts of the country, and the disease was completely eradicated from the Island in September, 1946.

METHODS OF CONTROL

Prior to 1895, there is no record of any preventive steps taken by the authorities except those which the village headmen were supposed to have taken. There were no qualified veterinarians. It is believed that the animals must have been treated by village cattle doctors known as " Vedaralas ". In 1901, a committee nominated by government with the Government Veterinary Surgeon, who was at that time attached to the Department of Public Instruction, as a member, drew up control measures which included the following (1) Northern ports of the Island to be closed for importation of cattle from India, (2) Control of the importation of cattle *via* Colombo, (3) A better system of reporting rinderpest—the headmen were to report first to the Provincial Government Agent, who in turn directed the Stock Inspector attached to his office to proceed to the spot where the disease had broken out. He also informed the Government Veterinary Surgeon, who gave further assistance to the Stock Inspector if required, (4) Existing laws to be strictly enforced—concealment of cases or neglect to isolate diseased animals to be followed by prosecution, (5) As a preventive, glycerinated bile to be inoculated, (6) Increase the resistance of the animals by improving the quality of the cattle and (7) Increase the number of veterinary personnel.

These measures did not in any way reduce the incidence of the disease in the Island. Importation of cattle from India continued and every outbreak was traced to some imported animal. Importation of cattle also could not be entirely stopped. However, in 1929, importation of cattle from Asian ports *via* Colombo was prohibited and spleen pulp vaccine, as prepared by Daubney in East Africa, was introduced into the field and the disease was eradicated in 1934. Ceylon remained free from rinderpest from 1934 to 1942, when a fresh introduction of the disease took place. This happened in a batch of goats which was imported from India and kept at the Quarantine Stations in Colombo and Kayts. This outbreak was suppressed in the Quarantine Stations itself. The first intimation that rinderpest had broken out among Ceylon cattle was from the Municipal Veterinary Surgeon in Colombo in January, 1943, a year later. The disease then was present among cart bulls in at least four widely-separated cattle sheds. From Colombo the disease spread to various other places. The circumstances which made it possible for the disease to infect our cattle may be summarized briefly as follows :—

(1) War conditions made it necessary to increase very greatly the number of sheep and goats imported from India. (2) It was necessary to amend the previous regulation that all sheep and goats from India would be imported *via* Colombo and would be slaughtered in the Colombo Slaughter House. Instead of all imported goats being slaughtered in Colombo, it was necessary to distribute living sheep and goats to many centres in remote parts of the country. (3) The greater part of the Municipal Quarantine Station in Colombo

had been requisitioned for emergency use and so was not available to quarantine the much-increased imports. (4) As a result of (3), makeshift and very unsatisfactory arrangements had to be made in Colombo for quarantine of the imported animals. (5) Normal administrative control proved to be unsuitable under emergency conditions and did not provide the necessary co-operation between the various interests involved, namely, the Government Veterinary Department, Municipal Veterinary Department, and the Military Supply Services.

Under the above limitations, the disease broke out in various parts of the Island, usually adjoining Military Supply Depots. At first the disease was combated with serum for contacts and spleen pulp vaccine for protective inoculation. In August, 1944, spleen pulp vaccine was replaced by goat virus which gave better results in protecting the local cattle, buffaloes and European cross-bred cattle. With the introduction of goat virus for mass vaccination and the Government Veterinary Surgeon assuming full power in the control of rinderpest, the whole campaign took a turn for the better as the goat virus vaccine proved very successful and created confidence among the veterinarians and cattle owners, which factor helped in the early eradication of the disease.

MEASURES USED TO COMBAT RINDERPEST

(1) *The Glycerinated Bile Method of Immunization.*—The glycerinated bile method of immunization tried by Robert Koch in South Africa was the first preventive vaccine used in Ceylon. It was used from 1901 to 1911, and only a few thousand head of cattle were injected. This method had to be abandoned for several reasons. The disadvantage of the bile method of immunization is that, if the bile is stained with a small quantity of blood, the inoculation of such material is liable to produce the disease and cause a high percentage of mortality. Immunity was not established immediately after inoculation but only about ten days later, and hence this method was of little use in immunizing cattle during an actual outbreak. This method had the further drawback that sufficient quantity of bile was not always available for immunizing large herds of cattle. In addition, the opening of the carcases was likely to cause resentment among the people on religious grounds.

(2) *Virulent Blood.*—Blood was drawn from the jugular vein of sick animals at the height of disease and run into a measuring glass containing citrated saline and then 1/500 formalin added, the proportion being one part virulent blood, one part citrated solution, and two parts of 1/500 formalin saline, making an ultimate dilution of 1/1000 formalin. The vaccine was kept in a dark place, unexposed to sunlight, for at least three days before use. This vaccine was given a trial in a small scale but found to be of little value and was discontinued.

(3) *Serum alone Method and Quarantine.*—The glycerinated bile method of immunizing was discontinued from 1912, and the serum alone method and quarantine were started. Under suitable conditions this method is of great value but it suffers from the disadvantage that the protection which it confers in an animal is of short duration, lasting only from ten to fourteen days. Because of this and the cost of the product it was not used extensively. Instead, existing quarantine laws were strictly enforced.

(4) *Simultaneous inoculation of Virus and Serum in the field.*—This method was also given a fair trial in Ceylon during the nineteen-twenties. By this method, the cattle are inoculated with serum just as in the case of the "serum alone" method but at the same time they receive an injection of virulent blood taken from an animal suffering from rinderpest. Following this simultaneous injection of serum and virulent blood, the injected cattle pass through a modified attack of rinderpest, recover, and are then immune against rinderpest. This method had to be carried out with safety as the disease was not enzootic in Ceylon. The inoculated animals had to be kept under rigid isolation for a period of two or three weeks while passing through the modified attack. The disadvantage of this method was the risk of spreading infection and the desired results were not obtained. The virus obtained in such a haphazard manner did not ensure uniformity of virulence, and exposed animals in an infected area were not proper subjects for this type of immunization. Moreover, the transmission of other blood diseases such as piroplasmosis and surra was facilitated and may have contributed to the high mortality.

(5) *Spleen Pulp Vaccine.*—About this time when trials were undertaken with Serum-Virus inoculations, Daubney claimed to have succeeded in immunizing cattle by using a vaccine prepared from the spleen of cattle suffering from rinderpest. Crawford in Ceylon prepared two batches of vaccine—one the way Daubney had prepared it, using formalin in the preparation, and the other chloroform-treated as done by the Philippine workers. The results of these experiments were encouraging. The formalized vaccine proved easier to work with, did not cause such painful swellings at the site of inoculation, and conferred a strong immunity. It therefore had some advantages over the chloroform vaccine. It suffered, however, from the disadvantages that it had to be used within a week of preparation, while it was claimed for the chloroform vaccine that it would keep for periods up to one year. By 1930, the spleen pulp vaccine was pushed ahead in the villages of the North-Central Province and encouraging results were obtained. However, this vaccine suffered from a few shortcomings in the second outbreak which occurred in 1943. In most cases a satisfactory degree of immunity was obtained but in some cases the results were disappointing. This failure was mainly due to the vaccine being of low potency and occurrence of low grade and fleeting immunity where a heterologous vaccine was used. If the vaccine was prepared from the spleen of a buffalo, it failed to induce immunity in cattle and *vice versa.* This was a serious drawback which made the author resort to goat virus vaccine.

The method employed in the preparation of the spleen pulp vaccine was as follows :—The spleen was first reduced to a fine pulp by passing through a fruit pulper, which proved to be very suitable for the work. The pulp was then weighed and one percent. hypertonic salt added. This was allowed to stand for 24 hours on ice in the ice chest. Sterilized water was then added to bring the concentration of salt to 9 per cent. Formalin at the rate of 1 : 1000 of the mixture was added and the whole allowed to stand for three days in the ice chest. It was then examined for evidence of contamination and if found satisfactory was bottled and issued. No vaccine older than 2 weeks was used.

TABLE I

Showing statistical Data on the effect of Rinderpest Vaccines and Sera on the incidence of Rinderpest in Ceylon

Year	Cases	Deaths	Doses of Rinderpest vaccine or sera	Remarks
1928	1,757	813	817	Serum used
1929	10,330	5,137	3,809	do.
1930	11,826	10,857	1,240	do.
1931	20,634	15,086	17,729	Spleen pulp vaccine single injection
1932	8,373	6,817	27,667	do.
1933	3,035	2,419	9,899	do.
1934	207	Figure not available	Figure not available	do.

When disease was again introduced in 1943—after 10 years freedom from this disease

Year	Cases	Deaths	Doses of Rinderpest vaccine or sera	Remarks
1943	3,789	3,025	246,068 cc	Spleen pulp
			35,900 cc	Serum
1944	4,882	3,856	554,508 cc	Spleen pulp
			431,500 cc	Serum
			240 cc	Goat virus
1945	4,818	3,188	70,500 cc	Serum
			36,742 cc	Goat virus
1946	1,289	888	107,900 cc	do.
1947			2,400 cc	do.

(2) *Goat Virus.*—It was in August, 1944, that Goat Virus was tried in the field. Edwards (1928), who was the first to introduce the use of goat virus in India, had two objects in view in recommending the use of this product as a method of immunization against rinderpest. Firstly, goat virus is free from protozoan parasites, and secondly, the virus is sufficiently attenuated for safe injection into susceptible cattle. One of the limitations of the goat vaccine method, however, is that its application is liable to produce untoward results in highly susceptible breeds of cattle. Preliminary experiments were carried out by the author in Ceylon on local cattle (Sinhala type), buffaloes, and cross-bred cattle, and the results were very encouraging. When a small dose of goat virus was given to local cattle there was a thermal reaction in addition to slight signs of digestive disturbances. A small dose of serum was all that was necessary to modify any severe reaction. In local buffaloes, a small dose of goat virus produced neither a thermal reaction nor any bodily disturbances. In cross-bred cattle, the reaction was slightly more marked, but with a little serum the method was entirely free from danger. Susceptible animals, even when kept in close contact with vaccinated animals, failed to contact rinderpest. When this vaccine was introduced into the field the results were so encouraging that it was used till the whole island became free of rinderpest. At the beginning it was feared that this vaccine, if used in the field, might produce carriers of the disease, but this fear was quelled when the field reports were encouraging. There was not a single instance in which the use of this vaccine produced any "flare up" of the disease. The reasons for the popularity of the goat virus are: (1) Method of preparation—simple and

can be undertaken by any veterinary officer. (2) Fresh viable vaccines available on the spot and inoculated animals show no ill effects. (3) Capable of producing quick immunity and thus its use in infective herds was responsible for clearing infection in a comparatively short time. (4) Cheaper than spleen pulp vaccine.

(7) *K. A. G. Virus* (*Goat tissue Vaccine*).—A dried virus obtained from Kabete Laboratory in East Africa was given a trial in the field. Results could not be recorded as it was replaced by Goat Virus in our work in this Island. No bad effects were noted but its efficacy could not be studied.

(8) *Slaughtering of Sick and Exposed Animals.*—Shooting of the affected animals was carried out when there was an outbreak of rinderpest in areas where large numbers of cattle had no owners, but this usually caused resentment among cattle owners. Very often when this was done cattle were moved to remote villages and jungles and thus new places became infected.

This practice was not encouraged by the veterinary authorities as a routine measure of combating rinderpest. The people too resented this method as Ceylon is predominantly a Buddhist country.

(9) *Strict Quarantine and Sanitation.*—In the rinderpest campaign in the country strict enforcement of proper quarantine and sanitary measures covering the entire infected areas were undertaken. In the 1943 outbreak military aid was obtained to round up animals which could not be caught in a district in East Ceylon. In another district, on account of the large number of ownerless cattle which roamed about in the open pastures, the unusual method of seizing the semi-wild cattle with the help of nets had to be adopted to vaccinate them. The method became very popular with the villagers as some of them were able to redeem their cattle.

When an outbreak occurred in a new area, the sick animals were rounded up and tied under sheds and in some villages healthy animals and contacts were also tied, about 10 yards apart, with strong ropes. No work passes were issued and all movements of animals were temporarily stopped during the fifteen-day tie up. The owners were obliged to bring food, water and individual drinking vessels in order to prevent the possibility of directly or indirectly spreading the disease. Watchers and guards were also appointed by Government to enforce strict sanitary measures and quarantine. Further, if one village was infected, besides the animals being tied up, the villages contiguous to this infected village were considered infected and proclaimed as such. An area about 5–10 miles in diameter was also proclaimed as the "protective zone". No movement of cattle from the infected zone to the protective zone was allowed and *vice versa*, and no animal was permitted to leave either of these zones. Guards employed by Government were placed at points of exit from these zones to prevent surreptitious removal of cattle. Working animals were allowed to move freely in the infected or protective zone after vaccination and with a permit from the Government Veterinarian in charge of the outbreak. Where sick animals were housed, a guard was placed on duty to see that no one entered other than the caretaker or authorized agent of the veterinary officer on duty. An area was declared free of rinderpest only if there were no fresh cases and if four weeks had passed from the date of the last death of a diseased animal.

As soon as an area was declared infected by the Government Agent of the Province or the Government Veterinary Surgeon, a census of all the animals in the infected and protective areas was taken, the source of infection traced, and a planned vaccination campaign undertaken. It is not possible, in a country with open fields, devoid of fences, and where animals roam freely for their food, to eradicate animal diseases by strict quarantine measures alone. That was why the Government attacked the problem of disease control by building up a permanent immunity which was to go hand in hand with other measures. At first the people strenuously objected to bringing their animals for vaccination, because of the inconvenience and also of the failure of the vaccine in some places due to improper handling. By diplomacy, tact, and the permanent immunity acquired by the treated animals, the people became convinced of the efficacy of the vaccine and a good response for vaccination was seen in the majority of places.

DISCUSSION

Ceylon is free from rinderpest for the second time. In 1934, this disease was eradicated from the Island after a campaign lasting about 39 years. Again, after a lapse of ten years, in 1943, the disease was introduced into the Island from India during war time. This 1943 outbreak was stamped out of the country by September, 1946. Enormous losses of livestock and tremendous expense of money were incurred, but they were well worth the sacrifice as the greatest deterrent in Ceylon to the development of animal industry and agriculture was rinderpest. The peculiar conditions under which the campaign had to be carried out were responsible for the repeated failure in the past ; the open fields devoid of fenced enclosures wherein all species of animals roamed freely for their food ; the ignorance of the people about the spread of infectious disease ; and the lack of sufficient veterinary personnel.

The spleen pulp vaccine prepared according to Daubney's method was helpful in building a solid immunity among vaccinated cattle resulting in the final eradication of the disease in 1934. Since this vaccine had its own disadvantages it was replaced by Goat Virus vaccine in the 1943 outbreak. The goat virus was sufficiently attenuated for safe injection into susceptible cattle, it was free from protozoan parasites and capable of producing quick immunity, and thus its use in infective herds was responsible for clearing infection in a comparatively short time. Another advantage was that this vaccine could be prepared by any veterinary officer and fresh viable vaccine was always available.

SUMMARY

1. Rinderpest has always been introduced into Ceylon from India. Before 1934, the disease broke out in Ceylon as a result of the importation of cattle for slaughter, draught, and dairy purposes. The disease was stamped out in 1934, but again introduced in 1943 through importation of cattle and goats for the military in large numbers and when no proper quarantine facilities were available.

2. The first attempt to combat this disease was by the Glycerinated Bile method of Koch. This was tried from 1901 to 1911, but was found to be impractical and was soon discontinued.

3. The simultaneous inoculation of serum and bull virus in the field was instituted in the nineteen-twenties. It proved to be ineffective because the virus obtained in the field was not uniform in virulence and exposed animals were not proper subjects for this type of immunization.

4. The serum alone method with quarantine was enforced since 1908. This failed because the protection offered lasted only 10 to 14 days.

5. The strict enforcement of quarantine and sanitary measures alone with the object of stopping the spread of the disease for fifteen-day periods in the hope that the infection would die out, did not succeed. Parallel mass vaccination of cattle and buffaloes had to be undertaken.

6. The introduction of Spleen pulp vaccine and building up an inmunity in the cattle was responsible for the eradication of disease in 1934.

7. The use of Goat Virus vaccine prepared on spot and used freshly and on a large scale finally eliminated the last vestiges of the infection which started in the year 1943, and in September 1946, the Island was officially declared free of rinderpest.

REFERENCES

Crawford, M. .. Annual Administration Report of the Government Veterinary Surgeon, Ceylon, for years 1931–1936.

Hoole, E. T. .. Annual Administration Report of the Acting Government Veterinary Surgeon, Ceylon, for the year 1907.

Hoole, E. T. .. Annual Administration Report of the Acting Government Veterinary Surgeon for the years 1911–1912.

Harward, J. .. Annual Administration Report of the Acting Director of Public Instruction, Ceylon (1898), pp. 33–35.

Rodrigo, E. .. Annual Administration Report of the Acting Director of Agriculture, Ceylon, for the years 1937–1942.

Sturgess, G. W. .. Annual Administration Report of the Government Veterinary Surgeon, Ceylon, for the years 1900–1906 ; 1908–1911 ; and 1913–1930.

Seneviratne, L. J. de S. .. Annual Administration Report of the Acting Director of Agriculture, Ceylon, for the years 1943–1946.

Mixed Farming

BY

C. R. TURBET

FORMERLY SPECIALIST IN ANIMAL HUSBANDRY (PRODUCTION)

KNOWLEDGE of the value of mixed farming as a means of providing social security to small farmers is now widespread. By adopting a diversified system of farming, the farmer is able to establish himself in a happy state of independence in which from the products of his farm he is almost if not entirely self-supporting in a well-balanced food supply for himself and family as well as for his livestock.

From the proceeds of the sale of cash crops he obtains funds for the purchase of clothing, household furniture and equipment, extra food, new livestock, material for farm improvement and the means of educating his children, the providing of entertainment and vacation and social security.

By mixed or diversified farming is meant the inclusion in the operation of the farm a well-balanced use of several kinds of livestock on the one hand and on the other the cultivation of several kinds of crops. In regard to the latter, it would be well for the farmer to plant both permanent and annual crops.

Permanent crops should include fruit trees as well as economic trees providing saleable products, fodder, firewood, fencing material and shade. In setting out the farm much thought is needed so that the permanent trees may be placed to the best advantage. They may constitute fence lines and so provide economy in fencing, wind breaks or shade trees and at the same time improve the appearance and comfort of the farm for man and animals. If fruit from the orchard is to be harvested, the orchard needs to be planted close by the home for its protection.

The area of a mixed farm in the wet tropics suitable for the care of the farmer and his family, without permanent extra labour would vary from five to ten acres. Of this area about one tenth should be set apart for house, farm buildings, vegetable garden and permanent fruit and other trees, except that trees may be planted elsewhere on the farm such as along boundary lines or for shade.

The kinds of trees planted must vary according to the location of the farm, whether it be in lowlands or uplands, wet or dry zones. A complete list of suitable trees need not be set down but those for which there is great affection should appear commonly in groups of mixed farms. The coconut palm, jak fruit, mango, arecanut and the citrus fruits provide foods for daily use. The kapok, material for his bed.

The vegetable garden will provide much of the daily food requirements and be particularly helpful in creating a ration well supplied with the vitamins when rice makes up the bulk diet. Some perennial plants will be included among those in the vegetable garden.

Among the main crops it will be found that some will be planted with unceasing regularity whilst others will vary according to market requirements. Some crops will be suited to special localities only whilst others may be more widely grown. There will be no doubt, however, that wherever it can be grown, rice will be the staple crop. It is not well to have all one's eggs in one basket and in conformity with the idea of mixed farming a rotation of crops will help towards security of profit and farm maintenance.

The more livestock kept the greater the amount of animal manure that will be available for the maintenance of soil fertility. Good judgment on the part of the farmer and his advisers will be needed in deciding on the livestock carrying capacity of the farm.

A certain area, approximately half of the farm should be set aside for the establishment of grassland for grazing. This area should be fenced and subdivided for rotational grazing if the best is to be got out of the pasture. One has to consider the desirability also of including the pasture land in a system of rotation with land which is being cultivated for crops. Where there has been considerable expenditure in the establishment of pasture in the way of fencing, draining, grading for irrigation and the planting of grass, it will be probably uneconomical to break it up to include it in rotation with crops.

If the farm is stocked to capacity it will carry more animals than can be maintained from grazing. It will be necessary therefore for the farmer to devote some of his arable land to the cultivation of fodder crops for his stock and to obtain grain, particularly for poultry feed although some grain could well be produced and fed as a concentrate to large animals.

If the stock were to be grazed all the time it would be difficult to collect or control the economical distribution and utilization of animal manure to maintain the fertility of his cultivation fields. It is well therefore to provide housing for the stock in which animals may be maintained at night and on very wet days. Bedding in the form of dry grass or straw should be provided both for the comfort of the animal and for the purpose of incorporating it in the animal manure to form humus.

There are two ways of handling the manure problem. One is to clean out the cattle pens daily, removing manure and soiled straw to manure pits for composting or a method described in the *Times of Ceylon* recently by Mr. Spencer Schrader in which straw at the rate of 7 lb. per animal is spread. The manure accumulation for the night is spread out over the old straw each morning and a further 7 lb. of straw per animal spread over the manure. The cattle are grazed during the day and fed about 3 lb. of coconut poonac. The cattle eat some of the straw or hay during the night and the balance is trodden in. The animals are not secured in the sheds under this system but are allowed free movement. Water must be provided in the shed. If 100 sq. ft. per animal is allowed the height of the accumulation of straw and manure will rise about fifteen inches in four months. In that time the underlying material will have become thoroughly decomposed, well compacted and solid. It is said that 10 tons of manure per annum per head may be provided by this method.

There is no reason why several different kinds of animals should not be kept with profit from each and added interest particularly to the family of the farmer. Cattle would undoubtedly make up his principal stock.

On ten acres of well-farmed land, his herd might consist of a pair of working bulls; three cows, averaging two in milk; three yearling animals, progeny of the cows and three calves. This is heavy stocking but can be done with reasonable soil, good rainfall or irrigation and by feeding extra rations.

A male goat and a pair of nannies may be kept on a very small area and be fed largely on surplus products of the vegetable garden. A single sow well housed would be sufficient for the farm. According to the fancy of the farmer and to the availability of foodstuffs, poultry should be kept in large or small numbers. The minimum number kept should be sufficient to produce his own needs in eggs and poultry flesh.

Apart from the manurial value of all his stock and the traction value of his bulls, the cows should provide on the rations consumed sufficient milk to nourish their calves; provide milk, butter and ghee for the family and if they are very good cows a small surplus of butter fat for sale. In addition, there should be profit from the sale of the animal surplus brought about by the birth and growth of three calves. The animals may either be sold under two years old or be used to replace adult stock. In the latter case equivalent adult stock should be sold. Under no circumstances should the animal increase be allowed to accumulate on the farm to bring about overstocking.

A pair of she-goats may be expected to produce a pair of twins each twice annually or thereabouts. There is good profit in this, whether the progeny are sold or consumed as food on the farm.

A single sow by producing two litters, averaging six survivors each, yearly will probably turn out to be the most profitable asset on the farm. Trouble comes when the small farmer fascinated by the profit from one sow decides greatly to increase his herd. He then comes up against the difficulty of supply from his farm sufficient highly nutritious food such as is required for pigs. Malnutrition then affects all the pigs and production becomes unprofitable.

To a mixed farmer poultry are most essential for the maintenance of health and good physical development of his family. They add interest to the farming and help to use up surplus food, converting this into profit. A certain number of mixed farmers will do well to develop the poultry farming side of his operations if sufficient food can be obtained and if a good market exists within marketing distance.

A useful development in a community of small mixed farmers would be to encourage each to own a small cream separator (the smallest made, separating fifteen gallons of milk per hour). The cream, produced at each farm, could be sent to a central factory (co-operative) which need not be large, and there converted into butter for sale as butter or for further conversion into ghee. The scheme is capable of considerable extension by multiplication of groups so that as it gains popularity the quantity of ghee produced becomes sufficient to be classed as a commercial industry. Such a scheme has succeeded in Tanganyika.

The idea of co-operative marketing may be extended to all of the products, both plant and animal, produced in a mixed farming community. It follows that a central village with market place and social amenities will spring up. It should be anticipated and receive the attention of a local town planning committee with an expert adviser.

It would be folly for a peasant farmer to set himself up alone in an isolated locality and expect to do well as a mixed farmer. Success is more likely to come to a group of farmers, who by their united efforts are able to clear substantial areas of jungle, drain it or irrigate it as the case may be, put in roads and provide social services.

Considerable capital is required also and few peasant farmers will be found in the beginning with sufficient capital to do all the things mentioned above. From some source funds should be made available for development and subsistence until the farmer commences to obtain income. Subsistence allowance may then cease but advances for development should continue under the watchful eye of a Government Officer (Agricultural Officer) as long as good development is taking place and the farming operations are conducted on an economical basis.

Associated also with each community of mixed farmers there should be a demonstration farm. This should in the first instance be pushed ahead and completely brought into production. It will give the farmers an ideal to strive for. Each single item of equipment, housing or development might be looked upon as a unit. The beginner strives to provide one unit for his own farm and then another, so that in the end he has a farm as well equipped as the demonstration farm.

In regard to the latter farm although full expenditure to what might have appeared an extravagant extent would be warranted to bring it on the early stages, subsequently the farm should be conducted on strictly economical lines. Full records should be kept for all items of expenditure and income so that farmers may be warned early of unprofitable undertakings.

Expert advice could be made available to new farmers in setting out their farms which should be well planned from the beginning. Such points as accessibility, possibility of putting in feeder roads, best site for the house to avoid flooding or to provide good drainage, wind breaks, water supply, land contour for draining or irrigation. The beginner also should start with good stock and plant material or seed.

There will be much that will go wrong in the early stages of development and some farmers will become disheartened. At this time they will need encouragement and the advice of well-trained and experienced officers. Epizootic disease may break out in their stock or more insidious nutritional disease or mineral deficiency may retard growth and development. Plant diseases may occur or fire or flood may cause disaster. These are the trials of pioneer farmers. Courage on their part and sympathetic and practical assistance from Government is needed at such times.

From what I have seen there does not appear to be land in the uplands suitable for development of mixed farms which is not already under some form of cultivation. Thousands of square miles of country, flat to gently undulating occur on the lowlands and which are now uninhabited. The land is fertile. By the provision of water, the control of diseases such as malaria by mass settlement, by the provision of amenities and by the encouragement of a high standard of living, rural life in the lowlands could undoubtedly be made attractive to many thousands of peasant farmers.

I trust that the picture I have painted is not too Utopian. To me the state of rural happiness described is a goal to strive for.

Some Notes on the Cultivation of Cabbage

J. J. NILES

MANAGER, VEGETABLE FARM, MAHAGASTOTA

SUMMARY

SOME notes on the cultivation of the common cabbage (*Brassica oleracea* var. *capitata* Linn) at Nuwara Eliya, are given in general in this article. Three factors which usually confront the cultivator are discussed. These are (*a*) the use of suckers or seed for propagation. (*b*) the effects of the severe wind and frost experienced during certain periods, and (*c*) the incidence of " Cut-worm " infestation.

SUCKERS AND SEED

In Ceylon, two terms are commonly used in reference to this crop: (i) " Seed Cabbage ", when raised from seed, and (ii) " Sucker Cabbage ", when propagated by suckers. In both these types suckers develop from the stems after the heads have been cut. The formation of such suckers is hastened by making a 1 in. deep down-ward slit across the cut-end of the stems. These shoots, which could also be used as a green vegetable, form more readily in the sucker cabbage. The suckers produced on the seed cabbage stems are not suitable for planting, as they tend to run into leaves and flowers, without forming heads. It is only the suckers of the sucker cabbage that are used for propagation. On the other hand, seeds are more readily produced in the seed cabbage plants; some plants sometimes running into flower even before head formation. It is only the seeds produced after heading in the seed cabbage plants, that should be used for propagation. If the plants show a tendency to run into flower, which occurs especially after a spell of dry weather, the method of making a small vertical slit on the stem, 1 in. above ground level with a pen-knife, and inserting a pebble to keep it open, would act as a check to a certain extent. Of these two types, the sucker cabbage is more commonly grown as it is easier to establish, is comparatively hardier and is free from club-root disease. Further, suckers could be readily obtained, unlike the production of seeds. An additional advantage is that the harvesting of a matured sucker cabbage crop could be delayed, if necessary. If comparatively warm weather prevails suckers do not succeed and only seed cabbage crops are grown.

SEASONAL EFFECTS

A table giving the particulars of the climate of Nuwara Eliya (elevation—6,170 feet), where this crop thrives best, is given in Appendix A. In the Nuwara Eliya District strong winds prevail during June and July and

with less severity in August and September. During these months, and particularly in the earlier part, the crops in the field suffer a considerable set-back. Growth is impeded and the formation of heads is delayed. The June/July winds are too severe for any plants to survive, unless they are on the leeward side of a hill or are heavily protected by wind-belts. However, no cultivator can afford to gamble by having a crop in the field at this time. The nurseries of the seed cabbage crops are advisedly sown towards the end of the windy season and the seedlings are planted out as early as possible, so that the crop can be marketed before the glut in early October. If direct wind prevails during transplanting, small twigs staked on the leeward side, as a support, would help the young plants to establish themselves more quickly and also prevent the tender stems from snapping. Grown-up plants could be protected by earthing-up. Sucker cabbage crops of 5–6 months duration, if planted out in April, would be sufficiently established to come through the windy season, and would meet the demands of the early market in September.

Another period when the climate has an adverse effect on the crop is in late January and February, when frost prevails during certain days leading to the scorching of the leaves. Frost also adversely affects transplanted seedlings when only a few weeks old, or older plants that are about to form heads. It is thus advisable to adjust the planting time so that these stages of the crop are avoided during this period. November is an ideal month for planting, so that the crops could be gathered in early January. On days when there is frost it is advantageous to water the plants very early in the morning, with a view of washing it down, before the ill-effects of the sun's rays set on it. Another practice that could be easily adopted to ward off such adverse effects of frost is to burn rubbish in heaps during the nights, so that the smoke sweeps over the planted area.

CUT-WORM

It has been found that fixing tin-collars over each plant is a very effective preventive measure against this pest. Open cigarette tins, the bottoms of which have been removed, serve the purpose. These tin-collars should be kept on as long as possible, until such time that it becomes difficult to slip the tins over the leaves and to remove them without damage. These tins should be periodically removed and the enclosed soil examined at intervals, depending on the incidence of the pest.

A decoction made from the leaves of the herbaceous plant *Lobelia nicotianaefolia*, found very commonly in the waste areas in the hills, has been found to be satisfactorily effective against this pest. The decoction is made by soaking for 10 days, 20 lb. of the leaves in 40 gallons of water with the addition of 1 lb. of common salt. The decoction could be applied with a watering can at the rate of 2 gallons per 100 sq. ft. The same leaves could be used again a second time by the addition of water and allowing it to stand for 7–10 days. For further use fresh leaves are required. It is necessary to apply the decoction regularly in order to keep the pest under control. This treatment will not need any additional expenditure during periods when the plants are normally watered.

Appendix A

	Jan	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Year
Average rainfall	6·95"	2·03"	4·00"	5·01"	8·47"	10·44"	10·98"	7·51"	8·23"	9·73"	9·20"	7·84"	90·48"
Average rain days (*days for which at least ·01" is recorded*)	14	7	11	15	18	25	24	22	20	22	22	17	217
Average wet days (*days for which at least ·04" is recorded*)	12	5	9	12	15	22	21	19	16	20	19	14	184
Average mean maximum temperatures	67·9°	69·6°	70·8°	71·3°	70·4°	65·8°	65·3°	66·2°	66·9°	67·6°	67·6°	67·8°	68·1°
Average mean minimum temperatures	46·3°	45·1°	46·2°	49·8°	53·3°	55·6°	54·8°	54·2°	53·1°	52·0°	51·6°	48·7°	50·9°
Average mean temperatures	57·1°	57·3°	58·5°	60·6°	61·9°	60·7°	60·1°	60·2°	60·0°	59·8°	59·6°	58·3°	59·5°
Humidity—*Day* (*1947*)	80%	72%	80%	80%	80%	84%	80%	86%	80%	80%	75%	82%	79·9%
Humidity—*Night* (*from minimum*) (*1947*)	87%	85%	87%	91%	93%	85%	85%	91%	82%	87%	86%	87%	87·1%
Amount of Cloud (1947)	8·0	5·5	6·8	7·4	7·0	9·4	7·9	9·4	9·0	8·0	6·0	7·6	7·7

BOOK REVIEW

Fream's Elements of Agriculture has had a unique distinction amongst text books of agriculture to run into several editions and reprints. First published in 1892 by the late Dr. W. Fream, it soon served as a standard work for students and farmers of British agriculture and the demand during the course of years that followed resulted in the issue of several editions and reprints. The 12th edition appeared in 1932 and was revised and substantially rewritten by the staff of the Cambridge School of Agriculture under the general editorship of Professor Sir Roland Biffen, F.R.S. Several reprints had also appeared and in 1945 the Royal Agricultural Society of England decided that the book should again be brought up to date. This task was entrusted to Dr. D. H. Robinson who secured the assistance of several other specialists in bringing about a complete revision of this book. The 13th edition which has appeared this year will still remain the incontestable standard book of British agriculture which in the compass of 691 pages covers every aspect of the subject. The information provided in the 24 chapters of the book is clear, concise and authoritative and is supplemented by numerous half tones, drawings and diagrams.

Although the crops dealt with are of little interest to students of tropical agriculture, the book is invaluable in providing the basic information which is fundamental to all agriculture whether in temperate or tropical regions. Of particular interest are the chapters on tillage and tillage implements, farm machinery, mechanical power, manures and manuring, plant breeding, the structure and functions of the animal body, foods and feeding, cattle, pigs, poultry and animal hygiene.— W. R. C. P.

S——J. N. A. 90660 (8 4)

Utilisation of Phosphatic Fertilisers by Plants, after their Absorption into the Soil

BY

G. BARBIER, B. CHABANNES
and A. MARQUIS

CENTAL STATION OF AGRONOMY, VERSAILLES.

(*From "Plant and Soil", Vol. 1, No. 1, January 1948, pp. 11–17*)

THE absorptive power of the soil, with respect to phosphates, is often considered harmful ; it is said to retain in practically unavailable forms the greater part of the soluble phosphates applied, and to do this not only in certain special types of soil, such as laterites, but in most soils. It is supposed that crops do not generally recover more than about 20 per cent. of phosphatic fertilizers. This opinion is based on 3 sets of facts.

1. The soluble phosphates incorporated in the soil become in time, more and more difficult to extract by chemical reagents.

2. It has sometimes been found that the efficiency of phosphatic fertilizers decreases rapidly with the time of contact with the soil, in the absence of any vegetation (Scarseth & Tidmore)[1].

3. If the quantities of phosphorus are compared in crops which have, and which have not been manured with phosphate, the difference is found to be small in relation to the dose applied, about 10 per cent., often less. The residual effect on a second crop is even smaller, and on a third almost nil, so that the sum of successive effects and even the summation for an infinite series of crops is far from total utilisation.

This view, as applied to most soils, is open to a serious objection. If plants could recover altogether only 1/5 of the soluble phosphates applied, it would be necessary, to maintain fertility, to supply the soil with 5 times the amount of phosphates consumed by the crop. Now, it seems likely that, in many soils, the fertility can be maintained *at its existing level* by merely restoring the amounts removed. This indeed was the opinion of the agronomists of the last century ; according to them if the phosphate reserves of the soil were maintained by addition of soluble phosphates, this reserve remained capable of releasing to a particular crop a constant quantity of phosphoric acid under given conditions. This implies that the total application of phosphates would be recoverable by a sufficiently prolonged succession of crops. It is this contradiction that we have tried to resolve.

I. Conservation of the efficiency of phosphatic fertilizers during 16 years in a loamy soil

Gericke[2] has recently established, in various soils, that the efficiency of phosphatic fertilizers is found to be scarcely reduced after 18 months ageing in bare land. But he agrees that it should continue to decrease slowly over a very long period. However, we have at Versailles an experimental field which has been under observation for 16 years. It was established by

Demolon and Burgevin in 1928. It comprises plots receiving annually a fixed dose of simple fertilizer, particularly superphosphate or basic slag. The soil is always kept free of vegetation, but receives normal cultivation.

In this soil, an average slightly acid loam (pH 6·3 in 1928, dropping to 5·8 in 1942), the phosphates incorporated have undergone profound modifications. If a graph is drawn, with abscissa to show the years (or what amounts to the same thing the total quantity of P_2O_5 used since the beginning) and with ordinates to show the totals of P_2O_5 estractable by mild reagents (particularly dilute acetic acid), it is noticed that these totals increase less and less quickly during the first years, but that it augments each year after by a constant quantity. The diagram obtained begins with a convex curve continuing as a straight line rising slightly. The presence of this slight rise shows that the fixation of the phosphates tends towards an equilibrium at which extractability is not nil. It needs about 5 years for each annual addition to complete its evolution.

Now, in this experimental field, the application of fertilizers ceased in 1941, (14 applications). We were then in 1944, dealing with a soil containing phosphatic fertilizer which on the average had aged 10 years, the last application being not far from the end of its evolution. We can therefore consider the efficiency of these fertilizers corresponds more or less to the "end-point" of the ageing.

In 1944, we took earth from these plots and used it as phosphatic fertilizer in pot-cultures of barley. We compared its fertilising action with that of the same quantity of the same fertilizer applied immediately before sowing.

Phosphatic manuring : 0,200 g. P_2O_5 for 10 Kg. of a brown limestone soil containing 12 per cent. of $CaCO_3$.
Weight of dry matter harvested.

	Without Phosphatic fertilizers	Phosphatic fertilizers in the natural state applied immediately before sowing	Phosphatic fertilizers after 10 years in slightly acid soil
Superphosphate ..	100 ..	186 ..	184
Basic Slag ..	100 ..	140 ..	177

The aged superphosphate exercised more or less the same fertilizing action as the recent Superphosphate. The aged slag was noticeably more effective than the fresh slag.

These results which confirm over a long period those of Gericke, do not agree with the doctrine of progressive inactivation of phosphates by irreversible fixation in the soil. If such an inactivation took place, it could only occur in the short interval between the application of the fertilizer and the rooting of plants sown immediately after the manuring.

II. Selective absorption of phosphatic fertilizers by plants and the conservation of soil reserves

Up to the present, the part played by the phosphatic fertilizers in the nutrition of plants has been assessed by the indirect method already mentioned, which consists of comparing the quantities of phosphorus contained in a harvest with and without fertilizer. This method rests on the assumption that plants borrow from the soil reserves the same quantity of phosphorus in the two cases. But appearances would be the same, if the plants were selectively taking the fertilizer and leaving the reserves.

In experiments on maize cultures on solutions in pots divided into 2 compartments (with division of the root system), one series of plants received a solution rich in phosphates (36 or 18 mg. P_2O_5 per litre) in one of the compartments, and a solution poor in phosphates in the other compartment (1·8 mg. P_2O_5 per litre). Another series received the same weak

solution in both compartments. We have observed that the weak solution in association with the rich solution supplied less phosphate to the maize than when associated with another weak solution.

Concentration of the weak solution after 24 hours (initial concentration = 1·8 mg. P_2O_5 per litre)	
Weak solution associated with weak solution	Weak solution associated with rich (18 mg.) solution
0·17	0·70

The excess take-up of one part of the roots reduced the intake of the others. The same experiment was repeated in earth in pots, and in the field. Superphosphate was mixed with a small proportion of soil (1/16 in the case of the pots), the mixture distributed in cylinders of metal mesh, scattered in the soil which had no phosphate fertilizer.

After cultivation, the total loss of phosphorus from the earth in the cylinders was determined by analysis. In pots, barley took about 60 per cent. of the phosphoric acid added in the cylinders, and 50 per cent. in the field.

Moreover, if a complete balance-sheet of phosphorus in these experiments is drawn up, the quantity actually taken from the fundamental reserves of the soil can be calculated, since the total quantity consumed by the plants is known (by analysis of the crops) and the quantity actually taken from the fertilizers. It is thus established that the soil reserves supply in the presence of fertilizers less phosphate to crops than in the absence of fertilizers. This action of sparing reserves in the soil reached 60 per cent. in pots, 40 per cent. in the field, representing 19·6 lb. P_2O_5 per acre.

It is thus explained why an addition of phosphatic fertilizers as a rule only increases the consumption of phosphates by crops to a moderate degree.

These facts also explain why the efficiency of phosphate fertilizers disappears rapidly on cultivated land, without denying its conservation on bare land.

III. Adsorption of phosphates at the surface of clays, especially in combination with alkaline-earth cations[3]

One fact remains surprising, the conservation of the efficiency of phosphatic fertilizers in bare soil, in spite of the progressive reduction of their solubility in certain chemical reagents. That is why we have sought to find whether the adsorption of phosphates in the soil does not show some feature capable of explaining this anomaly.

A. Demolon and Barbier[4] have established that the calcium of clays is directly concerned in the retention of phosphates, independently of all precipitation of calcium phosphates in the true sense of the term. The following facts confirm the existence of adsorption compounds comprising clay, calcium ions, phosphoric ions, quite distinct from true calcium phosphates, and specify the conditions of their formation.

1. Different clays (a sub-soil loam, a Kaolinite and a montomorillonite) retain in the form of a calcium salt much more phosphates than in the form of a potassium salt, even when the initial concentration of phosphates in the solution is markedly lower than the point of precipitation of calcium phosphates under the conditions of the experiment.

2. If the concentration in phosphates is varied, characteristic curves of typical adsorption phenomena are obtained ; the quantity of phosphates absorbed becomes proportionally lower as the concentration in the solvent is higher, both in Ca clays and in K clays.

3. Between about pH 6 and 7, alkalinisation by the addition of lime impedes the retention of phosphates by calcium clays, *i.e.*, favours the maintenance of phosphates in solution.

4. Equilibria are rapidly established ; the supplementary quantity of phosphates retained by the Ca clays practically attains a maximum after $\frac{1}{4}$ hr's. agitation of aqueous suspensions. The subsequent progress of the absorption of phosphates does not depend on the nature of the exchangeable cation.

5. In the absence of flocculating salt, the Ca clays only adsorb a small quantity of phosphates ; the adsorption increases very rapidly with addition of traces of a flocculating salt (Ca chloride or sulphate) up to a maximum, corresponding to complete flocculation of the clay (about 2N/100) as if the phosphoric ions could be retained only between two surfaces cemented by flocculation.

To define the quantitive importance of these calcium linked adsorption compounds in the soil as described above (which contains phosphatic fertilizers, 10 years old), we set out from the hypothesis that dilute acids, which easily detach exchangeable calcium, should separate in a short time the phosphoric ions thus retained. Obviously dilute acids (acetic or sulphuric) at pH 3·0 in the cold extract an important fraction of the applied phosphates, and that in an *almost* explosive fashion, as one can judge by percolating a thin layer of earth under reduced pressure so that the acid passes through the soil in a few seconds.

By 3 or 4 short acid extractions one can recover about $\frac{1}{3}$ of the fertilizers applied. Another $\frac{1}{3}$ separates instantaneously if one takes up the residue in very dilute alkali (2N/1000). The phenomena of reversion or " fixation " of the phosphates in the soil studied appears to consist essentially in a limited evolution of forms easily extractible by dilute acids into forms easily extractible by dilute alkalis* (probably in consequence of a slow adsorption by ferric hydroxides which finely coat the surface of mineral particles.) Now the passage from the 1st to the 2nd forms does not appear to inhibit to any marked extent the phosphorus intake of plants in the soil studied, for basic slag, of which the phosphoric acid remained much more easily extractible by dilute acids than that of superphosphate, does not show, after 10 years, an efficiency superior to that of superphosphate. This may explain why a loss of solubility in acid reagents does not necessarily involve a loss of efficiency.

Conclusion—One must not exaggerate the disadvantages of the absorptive power of soils in regard to phosphates. The present study does not resolve the question of whether a fraction of the soluble phosphates incorporated in the soil can form there compounds completely and definitely inert. But it does show that this fraction, if it is not absent, is comparatively small, at least in the soils, which do not cause an inactivation of phosphates on ageing.

REFERENCES

[1]. Scarseth, G. D. and Tidmore, J. W., The fixation of phosphates by clay soils. *J. Am. Soc. Agron. 26*, 152–162 (1934).

[2]. Gericke, S., Untersuchungen über die Umsetzungen zwischen Phosphorsaüre und Kalk im Boden. *Bodenk. ü. Pflanzenrnahr.* 32. 171 (1943)

[3]. Barbier, G., Chabannes, J. et Miallet, P., Absorption des ions phosphoriques ã la surface des colloides argileux par l'intermédiaire des alcalinoterreux. *Ann. Agron. 16*, n. s., 7–34 (1946).

[4] Demolon, A. et Barbier, G., Contribution a l' étude de l'évolution des phosphates solubles dans les sols mineraux. *Ann. Agron., 56*, 329–363 (1930).

*See on this subject the article by A. Dean. An attempted fractionation of the soil phosphorus, *J. Agr. Sci. 28, 234–246 (1938)*.

(Translated from the French by Mrs. R. Child, B.A., with the kind permission of the Editors of " Plant and Soil ".)

Coconut Research Scheme, Board of Management

MINUTES OF THE 98th MEETING OF THE BOARD OF MANAGEMENT, COCONUT RESEARCH SCHEME, HELD AT 9.30 A.M. ON SATURDAY, JANUARY 15, 1949, IN THE BOARD ROOM OF THE PLANTERS' ASSOCIATION OF CEYLON, 113, STEUART PLACE, COLPETTY

Apology for absence was received from Mr. Albert F. Peries, J.P., U.M., M.P.

MINUTES

The minutes of the previous meeting held on Saturday, November 20, 1948, which had been circulated were confirmed, without amendment.

CORRESPONDENCE

The final proofs of the Sinhalese leaflets printed in book form were tabled and approved

BOARD OF MANAGEMENT

(*a*) The Chairman in congratulating Mr. H. W. Amarasuriya on being appointed Minister for Commerce and Trade expressed regret that his valuable services would not continue to be available as he had resigned from the Chairmanship of the L. C. P. A. In extending a welcome to Mr. Thomas Amarasuriya, the new Chairman of the L.C.P.A., the Chairman said that Mr. Thomas Amarasuriya was not new to the Board, having been a representative of the old State Council in 1946–47.

(*b*) The Chairman on behalf of the Board congratulated Mr. Albert F. Peries, J.P., U.M., M.P., on having been elected Deputy Speaker of Parliament, and Mr. H. E. Peries, C.C.S., on having been appointed M.B.E. by H. M. the King.

STAFF

(*a* THE CHAIRMAN INFORMED THE BOARD OF DR. REGINALD CHILD'S INTENTION NOT TO ACCEPT A FURTHER CONTRACT WHEN HIS PRESENT CONTRACT EXPIRES. THE BOARD RECEIVED THIS NEWS WITH GREAT REGRET. After discussion the Board decided to :

(1) Promote Mr. W. R. N. Nathanael to Acting Technological Chemist and to send him to England for two years training as soon as arrangements can be made. Dr. Child undertook to assist in this during his leave in England.

(2) To advertise widely for a new Director as a separate post. The Board hoped that it would be possible to secure the services of an officer having wide experience but specialised in some branch of the Scheme's research or in statistics.

(*b*) The Chairman reported that as decided by the Board at the 97th meeting Mr. O. B. M. Cheyne had taken up duties as the Replanting Officer, Coconut Research Scheme, from January 4, 1949, and the post of Assistant Replanting Officer had been advertised in the local press, the closing date for applications being 15th January.

(*c*) The Chairman reported that Mr. F. B. F. Mudanayake has been appointed Store and Library Clerk and had assumed duties as from January 4, 1949. This was ratified by the Board.

(*d*) The Chairman informed the Board that the Director, the Replanting Officer and the Secretary had interviewed all the officers of the N.R.P.S., who had applied for the posts of Field Assistants to the Replanting Scheme and also a selected lot from other applicants, with the Farm School Diploma. Of the 371 non-farm school applicants a short list have been selected and called for an interview on 20th and when the final selections are made they will be reported to the Board.

FINANCE

The minutes of a meeting of the Sub-Committee appointed by the Board of the Coconut Research Scheme to consider the revision of the Coconut Research Scheme Ordinance with a view to stabilise the Scheme's finances, and consider staff terms of service, which had been circulated were tabled :

After considerable discussion on a proposal by Col. W. G. Mack, O.B.E., E.D., seconded by Mr. A. N. D. A. Abeyasinghe, the Board unanimously decided that the observations and recommendations made be accepted. The Chairman was authorised to take up with the Minister immediately the revision of the Coconut Research Scheme Ordinance as follows :

(i.) Wherever the word Scheme occurs, the word Institute should be introduced, changing the title "Coconut Research Scheme" to "Coconut Research Institute."

(ii.) That the number of small holders' representatives be increased from two to three ; and the additional member should be himself a small-holder not owning more than 25 acres of coconut land to be nominated by the Ceylon Coconut Producers' Co-operative Sales Union, Ltd.

(iii.) That the present rates of Cess be revised to :

Desiccated coconuts	..	$8\frac{3}{4}$ cents per cwt.
Fresh nuts	..	25 cents per 1,000 nuts
Coconut oil	..	$9\frac{3}{8}$ cents per cwt.
Copra ..	..	$6\frac{1}{4}$ cents per cwt.

(iv.) *Government Grant.*—That Government should provide in addition an annual grant of Rs. 150,000 a sum computed to be equal to average annual cess collections at the rate stated in (iii).

The Board decided to hold its next meeting in Colombo on February 19, 1949, at 9.30 a.m.

MR. E. MUTTUKUMARU

Col. W. G. Mack drew the attention of the members that this would be the last meeting which Mr. Muttucumaru will attend as the P. A. Representative and that the Board would lose the keen and clear insight of Mr. Muttucumaru at the Board. The Chairman, while endorsing the view expressed by Col. Mack, said that he always respected the view of Mr. Muttucumaru and he was a great help to him at Board Meetings. The Director on behalf of the staff wished to be associated with the above remarks.

The meeting terminated at 11.45 a.m. with a vote of thanks to the Chair and the P.A. of Ceylon for the use of their Board Room.

Rubber Research Scheme (Ceylon)

MINUTES OF THE NINETY-FIRST MEETING OF THE RUBBER RESEARCH BOARD HELD AT THE PLANTERS' ASSOCIATION HEADQUARTERS, COLOMBO, AT 2.30 P.M. ON MONDAY, MARCH 28, 1949

Present.—Mr. D. Rhind (Director of Agriculture) in the chair ; Dr. E. Rhodes, (Director) ; Mr. T. D. Perera, C.C.S., (Deputy Secretary to the Treasury) ; Mr. Francis Amarasuriya ; Mr. H. St. J. Cole-Bowen : Mr. F. H. Griffith, M.P. : Major Montague Jayewickreme, M.P. ; Mr. F. A. Obeyesekere and Mr. J. L. D. Peiris.

An apology for absence was received from Senator U. A. Jayasundera, K.C.

Before commencing the business of the meeting the Chairman announnced that this was the first meeting of the re-constituted Board and welcomed the new members as well as those who had served on the old Board.

1. MINUTES

(*a*) *Signing.*—Draft minutes of the meeting held on December 20, 1948, which had been circulated to members of the old Board, were signed by the Chairman.

(*b*) *Matters arising from the minutes*—

Station Waggon.—The purchase of a Bedford Utilevan was reported.

2. BOARD

Nominations to the new Board were reported and it was noted that the personnel of the Board as at present constituted was as follows :—

Ex Officio members :

The Director of Agriculture—Mr. D. Rhind, O.B.E. (Chairman.)
The Director, Rubber Research Scheme—Dr. E. Rhodes (Vice Chairman.)
Representing the Minister of Finance—Mr. T. D. Perera, C.C.S., Deputy Secre tary to the Treasury.

Nominated members :

Representing the Senate—

Senator U. A. Jayasundera, K.C.

Representing the House of Representatives—

Major Montague Jayawickreme, M.P.

Representing the smallholders—

Mr. F. A. Obeyesekera.

Representing the Planters' Association of Ceylon—

Mr. H. St. J. Cole-Bowen.
Mr. F. H. Griffith, M.P.

Representing the Low Country Products Association—

Mr. Francis Amarasuriya.
Mr. J. L. D. Peiris.

It was also reported that Mr. R. C. L. Notley had been nominated by the Planters' Association of Ceylon to act for Mr. F. H. Griffith during the latter's absence from the Island, with effect from April 1, 1949.

3. **STAFF**

(*a*) *Soil Chemist.*—The Chairman reported that Dr. L. A. Whelan, Soil Chemist, had confirmed his notice of resignation after the improved salary terms had been made known to him. It was noted that his contract would terminate on April 13, 1949.

(*b*) *Applications for posts of—*

(1) *Director.*—It was reported that 5 applications had been received. The applications were considered and it was agreed that the post be offered to Dr. E. Phillis, Ph.D., D.Sc. (Leeds) on a contract for three years.

(2) *Oidium Research Officer.*—It has reported that 10 applications had been received and that two of the applicants who were at present in Britain had been interviewed by a Selection Sub-Committee of the London Advisory Committee. The applications were considered and it was agreed that the post be offered to Dr. H. E. Young, D.Sc. (Queensland) on a contract for 3½ years. In view of the necessity of having him here without delay it was agreed that the High Commissioner for Ceylon in Australia be requested to assist Dr. Young in obtaining an early passage to Ceylon.

(3) *Senior Chemist.*—It was agreed that a selection be made after 30th April which was the closing date for applications.

Mr. J. L. D. Peiris left the meeting.

4. **REPORTS AND ACCOUNTS**

(*a*) *Director's report for the 4th quarter, 1948.*—was approved.

(*b*) *Statement of Receipts and Payments for the 4th quarter, 1948.*—was approved.

(*c*) *Estate accounts for October and November, 1948.*—were tabled.

(*d*) *Visiting Engineer's report.*—was adopted and it was noted that the recommendations made therein were receiving attention.

5. **EXCHANGE OF PLANTING MATERIAL WITH R.R.I. MALAYA**

Correspondence with the Rubber Research Institute of Malaya regarding the exchange of planting material of certain promising clones developed by the two Institutes was considered. The Board agreed with the principle of exchange but considered that the terms of exchange should be further discussed.

Messrs. Obeyesekera and Cole-Bowen left the meeting.

6. **ELECTRIC LIGHT FOR JUNIOR STAFF BUNGALOWS**

Estimates for wiring the junior staff bungalows and installation of a transmission line were considered and a supplementary vote was passed to cover the extra cost.

7. **REPRESENTATION ON LONDON ADVISORY COMMITTEE**

The Chairman's recommendation to the Permanent Secretary to the Ministry of Agriculture and Lands that Mr. L. Lord be asked to continue to serve on the Committee as the representative of the Ceylon Government was approved.

8. **SOUTH AMERICAN LEAF DISEASE**

The Director placed before the Board certain suggestions for protecting Ceylon plantation rubber against South American Leaf Disease (Dothidella Ulei). It was agreed that Government be asked to give effect to these suggestions.

The meeting then terminated.

Dartonfield,
Agalawatta, April 21, 1949.

C. D. DE FONSEKA,
Secretary-Accountant.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED JANUARY 31, 1949

Province	Disease	Fresh cases during the month	Cases up to date since Jan. 1, 1949	From Jan. 1, 1949, to Jan. 31, 1949			
				Deaths	Recoveries	Balance Ill	Number Shot.
Western Province	Foot-and-mouth	25	25	—	—	25	—
Colombo Municipality	Foot-and-mouth	1	1	—	—	1	—
	Rabies	8	8	8	—	—	—
Cattle Quarantine Station	Anthrax in (sheep & goats)	41	41	41	—	—	—
North-Central Province	Foot-and-mouth	1,452	1,452	—	1,094	358	—
North-Western Province	Foot-and-mouth	362	362	9	195	158	—
Sabaragamuwa Province	Prioplasmosi	10	10	3	6	1	—
Central Province	Foot-and-mouth	206	206	—	128	78	—

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

Peradeniya, February 24, 1949.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED FEBRUARY 28, 1949

Province	Disease	Fresh cases during the month	Cases up to date since Jan. 1, 1949	From Jan. 1, 1949, to Feb. 28, 1949			
				Deaths	Recoveries	Balance Ill	No. Shot
Western Province	Foot-and-mouth	127	152	—	140	12	—
Colombo Municipality	Foot-and-mouth	37	38	—	38	—	—
	Rabies	4	12	12	—	—	—
Cattle Quarantine Station	Anthrax in (sheep & goats)	3	44	44	—	—	—
Northern Province	Anthrax	3	3	3	—	—	—
North-Central Province	Foot-and-mouth	312	1,764	—	1,653	111	—
North-Western Province	Foot-and-mouth	3,311	3,472	296	2,154	1,022	—
Sabaragamuwa Province	Piroplasmosis	—	10	3	7	—	—
Southern Province	Rabies	4	4	—	—	—	4
Central Province	Foot-and-mouth	173	379	—	306	73	—

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry) and Government Veterinary Surgeon.

Peradeniya, April 29, 1949.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED MARCH 31, 1949

Province	Disease	Fresh cases during the month	Cases up to date since Jan. 1, 1949	From Jan. 1, 1949, to Dec. 31, 1949			
				Deaths	Recoveries	Balance Ill	No. Shot
Western Province	Foot-and-mouth	48	200	2	151	47	—
Colombo Municipality	Foot-and mouth	42	80	—	80	—	—
	Rabies	5	17	17	—	—	—
Cattle Quarantine Station	Anthrax (sheep & goats)	8	52	52	—	—	—
Northern Province	Anthrax	—	3	3	—	—	—
	Foot-and-mouth	96	96	3	20	73	—
North-Central Province	Foot-and-mouth	92	1,856	—	1,825	31	—
North-Western Province	Foot-and-mouth	432	3,904	306	3,189	409	—
Sabaragamuwa Province	Piroplasmosis	—	10	3	7	—	—
Southern Province	Rabies	—	4	—	—	—	4
Central Province	Foot-and-mouth	13	392	—	375	17	—
	Rabies	8	8	8	—	—	—

Peradeniya, May 30, 1949.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

METEOROLOGICAL REPORT, JANUARY, 1949

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	88·5	+0·3	69·9	—0·7	78	95	4·7	6·48	12	—0·80
Anuradhapura	82·3	—1·1	69·9	+0·6	78	93	4·8	6·03	10	+0·23
Badulla	75·8	—0·6	63·1	—0·6	84	94	5·6	8·54	14	—1·78
Batticaloa	82·1	+0·5	73·8	+0·3	79	88	5·8	9·50	11	—3·38
Colombo	87·2	+0·7	71·9	+0·1	74	90	4·8	1·50	7	—2·46
Diyatalawa	70·6	—1·4	57·1	—0·4	86	94	6·6	4·71	15	—1·93
Galle	83·1	—0·9	73·0	0	82	90	5·0	4·89	9	+1·01
Hakgala	65·1	—1·9	55·0	+3·6	84	91	7·6	10·31	14	—2·12
Hambantota	85·4	+0·4	73·0	+0·4	78	88	5·4	6·35	6	+2·35
Jaffna	82·5	—0·5	71·2	—0·9	77	90	4·3	6·30	5	+1·89
Kandy	83·6	0	66·8	—0·3	74	87	5·5	2·75	8	—3·59
Kurunegala	86·3	—0·3	70·2	+0·4	73	90	4·3	2·77	8	—2·34
Lunuwila	87·3	—0·5	71·3	+0·3	76	93	4·2	1·28	4	—2·31
Mannar	82·0	—1·4	74·4	+0·2	77	81	3·9	1·79	7	—2·05
Nuwara Eliya	66·9	—0·9	45·2	—1·4	84	90	5·4	6·43	11	—0·53
Puttalam	85·0	—0·5	69·6	—0·4	80	93	4·6	4·50	6	+1·07
Ratnapura	90·0	+0·6	70·8	—0·3	74	95	5·8	4·63	10	—1·63
Talawakele	74·7	+0·4	55·4	0	70	82	5·3	3·23	7	—0·64
Trincomalee	80·4	—0·2	75·2	0	80	84	4·6	7·53	14	—0·78

Rainfall in January was below normal over the major part of the Island. The larger deficits occurred chiefly near the east coast and in the northern and north-eastern parts of the central hills,the highest being 10·81 inches at Kal-aar, 10·63 inches at Iddumekelle Estate and 7·13 inches at Pallegama. Excesses were generally small and occurred in the north and the extreme south, and scattered in places elsewhere over the Island. The largest excesses were 7·66 inches at Timitar Estate, 6·03 inches at Elephant Pass, 5·65 inches at Denagama, 5·02 inches at Uva Estate and 4·92 inches at Mahadova Estate.

Rainfall was heaviest on the north-eastern slopes of the hills, as is usual for this time of year, several stations recording totals over 25 inches, e.g., 33·79 inches at Upper St. Martin's Estate, 33·29 inches at Hendon Estate and 30·61 inches ta Uva Estate. Rainfall in the southern parts of Batticaloa District ranged from 10 to 15 inches, while along the west coast and in the south-western hill country it was less than 5 inches. Around Mannar, Chilaw and Colombo the total rainfall for the month was less than 2 inches.

There were 31 daily falls of 5 inches or over in January, nearly all of them occurring between the 9th and 12th. The highest were 7·45 inches at Hendon Estate and 7·13 inches at Upper St. Martin's Estate on the 11th, and 7·20 inches at Iranaimadu on the 1st.

Temperatures were in the main about normal. The maximum recorded shade temperature was 93·8° at Ratnapura on the 27th, while the lowest air temperature was 31·9° at Nuwara Eliya on the 25th. Humidities were generally above average by day, and below average by night. Cloud amounts were in excess. The prevailing wind direction was north-easterly.

Ground frost was reported from Nuwara Eliya and Kandapola from 21st to 25th.

D. T. E. DASSANAYAKE,
Superintendent Observatory.

METEOROLOGICAL REPORT, FEBRUARY, 1949

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	90·4	+0·5	68·7	—2·4	75	97	3·8	0·38	4	— 5·11
Anuradhapura	86·7	—0·3	68·5	—1·1	70	92	4·2	1·33	5	— 0·39
Badulla	74·6	—4·5	60·0	—3·2	75	94	4·2	3·72	6	+ 0·55
Batticaloa	82·9	—0·1	72·0	—1·8	76	88	5·0	1·26	8	— 2·95
Colombo	88·2	+1·0	69·8	—2·4	67	93	4·0	0·14	2	— 2·46
Diyatalawa	73·7	—1·1	55·2	—1·6	72	82	5·3	1·40	9	— 0·97
Galle	84·0	—1·4	72·9	—0·8	76	85	4·8	0·17	2	— 3·12
Hakgala	—	—	—	—	—	—	—	0·81	5	— 3·26
Hambantota	85·4	—0·6	71·5	—1·6	78	88	4·2	2·72	1	+ 1·26
Jaffna	86·0	+0·4	71·8	—0·6	70	88	4·3	0·10	3	— 1·36
Kandy	86·6	—0·1	64·0	—3·1	64	86	4·2	1·43	5	— 0·88
Kurunegala	90·0	—0·1	66·8	—3·0	64	89	2·8	0·55	3	— 1·44
Lunuwila	89·3	—0·7	70·1	—1·4	71	93	3·0	0·48	3	— 1·06
Mannar	85·4	—0·9	72·4	—1·4	73	85	4·1	0·18	1	— 1·52
Nuwara Eliya	68·9	—0·7	41·6	—3·3	74	81	3·6	0·59	6	— 1·40
Puttalam	87·0	—1·4	68·2	—2·2	72	92	3·6	0·71	4	— 0·66
Ratnapura	92·4	+0·8	69·3	—2·1	67	90	5·0	1·40	7	— 3·90
Talawakele	77·0	+0·5	52·0	—2·6	55	74	3·3	0·45	4	— 1·52
Trincomalee	82·4	—0·2	74·0	—1·8	76	84	4·0	1·38	3	— 1·27

There was very little rain over the Island in February, a majority of the stations receiving less than two inches for the whole month. Larger totals occurred on the north-eastern slopes of the hills, in Batticaloa District and at a few stations in the South-West, where several stations recorded over 5 inches, the outstanding aggregates being 13·07 inches at Hapugastenne Estate, 11·82 inches at Lugal Oya Estate, 9·72 inches at Uva Estate and 9·00 inches at Iddumekelle Eatate. There were a few scattered stationswhich received no rain at all.

The rainfall was mostly below normal, small excesses being recorded in limited areas in Uva Province. Batticaloa District and in the South-east. The lagrest excesses were 6·98 inches at Hapugastenne Estate, 3·98 inches at Uva Estate and 3·93 inches at Lugal Oya Estate, and the largest deficits 6·86 inches at Udugama, 5·98 inches at Opata and 5·44 inches at Sunderland Estate.

There were 3 daily falls of five inches or over in February, the highest being 7·39 inches at Lugal Oya Estate on the 1st.

Temperatures were slightly below average. The highest recorded shade temperature was 95.8° at Ratnapura on the 21st and 22nd, while the lowest air temperature was 31·4° at Nuwara Eliya on the 26th. Humidities were generally above average by day, and below average by night. Cloud amounts more in excess. Wind direction was north-easterly.

Ground frost was reported from Nuwara Eliya and Kandapola on several days, notably from 21st to 25th.

D. T. E. DASSANAYAKE,
Superintendent Observatory.

METEOROLOGICAL REPORT, MARCH, 1949

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	91·2	−1·3	71·2	−0·9	76	98	3·8	5·87	12	— 4·26
Anuradhapura	92·8	−1·7	72·4	+0·9	62	95	2·6	3·08	3	— 1·07
Badulla	83·5	−1·2	62·6	−1·7	70	94	3·8	4·23	5	— 0·82
Batticaloa	85·6	−0·2	74·9	−0·1	76	90	4·0	0·08	3	— 3·39
Colombo	88·7	−0·7	74·0	0	74	93	2·5	6·08	7	+ 1·42
Diyatalawa	78·8	−1·6	56·4	−1·8	64	88	4·4	1·89	4	— 3·00
Galle	87·0	−0·7	74·4	−0·7	74	90	4·2	2·76	8	— 2·55
Hakgala	73·3	−0·3	54·4	+2·4	61	65	4·7	4·23	6	— 2·09
Hambantota	87·2	−0·4	74·0	−0·2	76	90	2·2	0·88	3	— 2·51
Jaffna	89·6	−1·1	75·6	−0·2	68	88	1·6	0	0	— 1·58
Kandy	92·4	−3·7	69·1	+0·6	58	85	3·0	1·57	3	— 4·27
Kurunegala	96·1	−3·3	72·5	+0·5	56	90	2·6	1·41	4	— 4·87
Lunuwila	92·4	−2·6	74·0	+0·6	68	90	2·8	0·17	2	— 5·14
Mannar	89·9	−0·6	75·4	+0·3	71	88	1·8	0·20	2	— 1·64
Nuwara Eliya	71·9	−1·1	43·8	−2·5	57	82	3·2	2·55	4	— 1·54
Puttalam	91·6	−1·8	73·1	+0·2	64	93	2·6	1·36	3	— 1·72
Ratnapura	95·3	−3·5	72·2	−0·4	66	90	4·7	5·32	9	— 5·06
Talawakele	80·9	−3·1	53·7	−1·7	51	72	3·0	1·66	4	— 2·96
Trincomalee	86·1	−0·7	76·9	+0·5	76	84	2·1	0	0	— 2.30

Weather conditions during March were mainly warm and dry, there being only five days with any appreciable rain, the 7th and 8th and the last three days of the month. Rainfall was consequently below normal throughout the Island except at a few isolated stations where it was slightly in excess. Larger deficits of the order of 5 to 10 inches occurred in the southern and south-western parts, the greatest shortfalls being, 10·57 inches at Annangkande Estate, 10·51 inches at Opata and 10·33 inches at Carney Estate. The only excesses over 2 inches were 2·33 inches at Illukkumbura, 2·14 inches at Diwela Estate and 2·10 inches at Maligakanda.

The largest rainfall totals occurred in the south-western parts where the amounts generally ranged from 5 to 10 inches, the highest being 9·96 inches at Rasagalla Estate, 9·74 inches at Illukkumbura, 9·55 inches at Diwela Estate, and 9·50 inches at Kottawa. In the north and the east the rainfall was generally below two inches, Jaffna Peninsula and the north-eastern parts near Trincomalee-Mullaittivu getting nothing at all.

There were seven daily falls over 5 inches, six of these occurring on the 31st. The highest was 5·50 inches recorded on this day both at Buttala and Pooprassie Estate.

Temperatures were appreciably above average by day. The highest recorded shade temperature was 99·1° at Ratnapura on the 23rd, a very close second being 98·9° at Lunuwila on the 11th. The lowest air temperature was 33·9° at Nuwara Eliya on the 18th. Humidities were distributed on either side of average while cloud amounts were in deficit. Wind direction was generally north-easterly.

Ground frost was reported from Nuwara Eliya and Kandapola on several days, particularly the 17th and 18th.

D. T. E. DASSANAYAKE,
Superintendent Observatory.

List of New Acquisitions to the Library, Department of Agriculture, Peradeniya, for the Period, January 1, 1949, to March 31, 1949

BOOKS

1. Growth Hormones in Plants—by P. B. Jensen (Issued to A. R. O., Maha Illuppalama).
2. United States Department of Agriculture, Agricultural Statistics, 1947.
3. Manual on Research and Reports (Issued to the A. R. O., Maha Illuppalama).
4. A Source Book of Agricultural Chemistry—by C. A. Browne (Issued to A. R. O. M. I.)
5. A Catalogue of Insecticides and Fungicides—by Frear (Issued to A. R. O. M. I.).
6. British Dairying—by F. H. Garner.
7. Index Veterinarius, Volume 14, 1947–48.
8. United States Department of Agriculture, Yearbook, 1948—Grass.
9. Plant Science Formulae—by Mclean & Cook.
10. Farming and Mechanized Agriculture, 1948—by R. G. Stapledon.
11. Profit from Fertilizers, 3rd Edition—by Hoare, Garner *et al.*
12. Soil Physics—2nd Edition—by Baver (Issued to A. R. O., Maha Illuppalama).
13. Planters' Notebook, 9th Edition—by Rutherford (Issued to D. A. O. S. C., Bandarawela).
14. The Feeding of Crops and Stock, Parts I, II and III—by A. D. Hall (3rd Edition) (Issued to the Girls' Farm School, Kundasale).
15. Practical Goat Keeping—by A. Abbey (Issued to the Girls' Farm School, Kundasale).
16. Ducks and Geese and How to Keep Them—by Chatterton (Issued to the Girls' Farm School, Kundasale).
17. Food Values—by MCkillop (4th Edition) (Issued to Girls' Farm School, Kundasale.)
18. A Practical Course in Agricultural Chemistry—by Knowles & Watkin, 2nd Edition. (Issued to the Girls' Farm School, Kundasale).
19. Diagnostic Methods in Veterinary Medicine, 2nd Edition—by G. F. Boddie. (Issued to the Girls' Farm School, Kundasale).
20. Tropical Planting and Gardening, 5th Edition—by H. F. Macmillan (Issued to the Girls' Farm School, Kundasale).
21. An Introduction to Biology—by E. J. Hatfield (Issued to the Girls' Farm School, Kundasale).
22. Modern Poultry Management—by Howes (Issued to the Girls' Farm School, Kundasale).
23. Fruit Growing—by N. B. Bagenal, 2nd Edition (Issued to the Girls' Farm School, Kundasale).
24. Stockbreeding and the Artificial Insemination of Livestock—by Milovanov & Sokolovskaya (Issued to the Girls' Farm School, Kundasale).
25. Food Facts and Diet Planning—by G. Macdonald (Issued to Girls' Farm School, Kundasale).
26. Types and Breeds of Farm Animals—by C. S. Plumb (Issued to Girls' Farm School, Kundasale).
27. How to Study Birds—by S. Smith (Issued to Girls' Farm School, Kundasale).
28. Elements of Dairying—by T. M. Olson (Issued to Girls' Farm School, Kundasale).
29. Recent Developments in Cattle Breeding—by G. F. Finlay (Issued to Girls' Farm School, Kundasale).
30. Diseases and Parasites of Poultry—by Barger & Card, 3rd Edition (Issued to Girls' Farm School Kundasale).
31. Basic Horticulture—by V. R. Gardner (Issued to Girls' Farm School, Kundasale).
32. The Book of the Goat—by H. S. H. Peglar, 8th Edition (Issued to Girls' Farm School, Kundasale).
33. The Anatomy of Domestic Animals, 3rd Edition—by Sison & Grossman (Issued to Girls' Farm School Kundasale).
34. Proceedings of the Soil Science Society of America, Volume 12, 1947.
35. The Colonial Office List Map Supplement.
36. Dairy Enterprises—by Field & Mcdowell (Issued to D. A. O. S. C., Bandarawela).
37. Surveying for Agricultural Students and Farmers—by Stewart & Grassie (Issued to the Divisional Agricultural Officer, South Central, Bandarawela).
38. Principles of Farm Mechanics—by Sharp & Sharp (Issued to A. R. O., Maha Illuppalama).
39. Irrigation Principles and Practice—by Israelson (Issued to A. R. O., Maha Illuppalama).
40. The Growing Plant—by Nielson-Jones (Issued to Girls' Farm School, Kundasale).
41. Charter for the Soil—by Drummond (Issued to Girls' Farm School, Kundasale).
42. Reconstruction by Way of the Soil—by Wrench (Issued to Girls' Farm School, Kundasale).
43. Green Pastures—by Littlebury Co (Issued to D. A. O. S. C., Bandarawela).
44. Silos and Silage—by H. I. Moore (Issued to D. A. O. S. C., Bandarawela).
45. Veterinary Surgery—by Dollar, 3rd Edition (Issued to D. A. O. S. C., Bandarawela).
46. Tropical Planting and Gardening—Macmillan, 5th Edition (Issued to D. A. O. S. C., Bandarawela).
47. Rich Land, Poor Land—by Chase (Issued to D. A. O. S. C., Bandarawela).
48. Citrus Diseases and their Control—by Fawcett (Issued to Horticultural Officer).
49. Growth Hormones in Plants—by Jensen (Issued to Horticultural Officer).
50. Fundamentals of Fruit Production—by Gardner, Bradford, and Hooker (Issued to Horticultural Officer).
51. Manual of Determinative Bacteriology—by Bergey, 6th Edition (Issued to Veterinary Research Officer).
52. Immunity Principles and Application—by Zinnser, Enders & Fothergill, 5th Edition (Issued to Veterinary Research Officer).
53. Veterinary anaesthesia—by J. G. Wright, 2nd Edition (Issued to Veterinary Research Officer).
54. Lander's Veterinary Toxicology—by Nicholson, 3rd Edition (Issued to Veterinary Research Officer).

4——J. N. A 90680 (8/49)

55. Clinical Laboratory Diagnosis—by Levinson & Macfate, 3rd Edition (Issued to V. R. O.).
56. Farming for Industry—by R. O. Whyte.
57. Soil Fertility—by Malherbe.
58. The Soils that Support Us—by Kellog (Issued to Girls' Farm School, Kundasale).
59. Tropical Gardening and Planting—by Macmillan, 5th Edition (Issued to Horticultural Officer).
60. Machines for the Farm, Ranch, and Plantation—by Turner & Johnson.
61. Principles of Crop Husbandry in India—by Yegna Narayan Iyer (Issued to Botanist).
62. Plant Families, How to Know Them—by H. E. Jacques (Issued to A. R. O., Maha Illuppalama).
63. Pregnancy Diagnosis Tests—A Review—by A. T. Cowie (Issued to V. R. O.).
64. Poultry Farming in the East—by Fawkes, 9th Edition (Issued to D. A. O. S. C., Bandarawela).
65. The Book of Good Housekeeping, Revised Edition (Issued to Girls' Farm School, Kundasale).
66. A Student's Handbook of Housewifery—by A. M. Kaye (Issued to Girls' Farm School, Kundasale).
67. Modern Home Laundrywork, Revised Edition (Issued to Girls' Farm School, Kundasale).
68. Interior Decorating—by Miller (Issued to Girls' Farm School, Kundasale).
69. The Edinburgh Handbook of Housework (Issued to Girls' Farm School, Kundasale).
70. Furnishing the Small Home—by Merivale, New Edition (Issued to Girls' Farm School, Kundasale).
71. Gall Midges of Economic Importance, Volume IV—by Barnes.
72. The Edinburgh Book of Plain Cookery Recipes, Revised Edition (Issued to Girls' Farm School, Kundasale).
73. The Edinburgh Book of Advanced Cookery Recipes (Issued to Girls' Farm School, Kundasale).
74. Decay of Timber and its Prevention—by Cartwright & Findlay (Issued to Pathologist).
75. Index Kewensis, Supplement X—by Hill & Salisbury (Issued to Assistant Systematic Botanist).
76. Annual Report of the Smithsonian Institution, 1947.
77. Report on Transport Conditions in Ceylon—by D. R. Rutnam.
78. Stingless Bees of the Western Hemisphere—by H. F. Schwarz.
79. United States Department of Agriculture Yearbook, 1942 (Issued to the Girls' Farm School, Kundasale).
80. Farm Machinery—by Culpin, 3rd Edition.
81. Tropical Planting and Gardening—by Macmillan, 5th Edition.
82. Sequential Analysis—by A. Wald.
83. Fundamentals of Soil Science—by Millar & Turk (Issued to Girls' Farm School, Kundasale).
84. The Grafter's Handbook—by R. J. Garner.
85. The Physiology of Farm Animals—by Marshall & Halnan, 4th Edition.
86. Botany Principles and Problems—by Sinnott (4th Edition). (Issued to Girls' Farm School, Kundasale.)
87. Dairy Farming—by V. C. Fishwick.
88. The A B C and X Y Z of Bee Culture—by Root & Root (Issued to Girls' Farm School, Kundasale).
89. Statistical Methods for Research Workers—by R. A. Fisher, 10th Edition.
90. Modern Poultry Husbandry—by L. Robinson.
91. Principles of Animal Hygeine and Preventive Veterinary Medicine—by L. Van Es.
92. Sons of the Soil—by W. Burns, 2nd Edition (Issued to D. A. O. S. C., Bandarawela).
93. Plant Science Fomulae—by Mclean & Cook (Issued to Chemist).
94. Cultivated Plants of the Farm—by G. H. D. Bell.
95. Elements of Agriculture—by Fream, 13th Edition (Issued to D. A. O. S. C., Bandarawela).
96. Farming and Mechanised Agriculture, 1948—by R. G. Stapledon (Issued to the Girls' Farm School, Kundasale).
97. Farm and Garden Seeds—by S. P. Mercer, 2nd Edition.
98. Sunflower for Food, Fodder and Fertility—by E. F. Hurt, 2nd Edition.
99. The Pasteurization of Milk—by G. S. Wilson.
100. The Science of Nutrition—by H. C. Sherman.
101. Twenty Years of Seed Research—by Baryon & Crocker.
102. Common British Grasses and Legumes—by Thomas & Davies, 3rd Edition.
103. Soil Fertility Renewal and Preservation—by E. Pfeiffer, 2nd Edition.
104. Diseases of Poultry—by W. P. Blount.
105. Diseases of Poultry—by E. Gray, 2nd Edition.
106. Animal Breeding—by A. L. Hagedoorn, 3rd Edition.
107. Leguminous Forage Plants—by D. H. Robinson, 2nd Edition.
108. Farm Buildings—by E. Gunn, 3rd Edition.
109. Ploughing in Prejudices—by Faulkner.
110. Insect Natural History—by A. D. Imms.
111. Textbook of Geology—by Leake & Rastall, 5th Edition (Issued to Girls' Farm School, Kundasale).
112. Plant Physiology—by Thomas, 3rd Edition (Issued to Girls' Farm School, Kundasale).
113. Modern Inorganic Chemistry—by Mellor, New Edition (Issued to Girls' Farm School, Kundasale).
114. Organic Chemistry—by Perkin & Kipping, Revised Edition (Issued to Girls' Farm School, Kundasale).
115. Earth Lore—by S. J. Shand, 2nd Edition (Issued to Girls' Farm School, Kundasale).
116. An Introduction to the Scientific Study of the Soil—by Comber, 3rd Edition (Issued to Girls' Farm School, Kundasale).
117. Insect Pests—by E. I. Ellis (Issued to Girls' Farm School, Kundasale).
118. The Virus, Life's Enemy—by K. M. Smith (Issued to Girls' Farm School, Kundasale).
119. Plant Biology—by H. Godwin, 4 th Edition (Issued to Girls' Farm School, Kundasale).
120. Chemical Analysis of Foods—by H. E. Cox, 3rd Edition (Issued to Girls' Farm School, Kundasale).
121. Agricultural Geology—by Rastall (Issued to Girls' Farm School, Kundasale).
122. Philips' International Atlas, 5th Edition (Issued to Propaganda Officer).
123. Cane Sugar Handbook—by Spencer & Meade, 8th Edition (Issued to D. A. O. S. C., Bandarawela).
124. Basic Horticulture—by V. R. Gardner (Issued to Horticultural Officer).
125. Diseases of Field Crops—by J. G. Dickson.
126. Agricultural Economics—by B. H. Hibbard.
127. The A B C and X Y Z of Bee Culture—by Root & Root (Issued to D. A. O. S. C., Bandarawela).
128. The Culture of the Orange and Allied Fruits—by H. C. Powell.

129. Dairy Manufacturing Processes—by Fouts & Freeman.
130. Successful Poultry Management—by M. A. Jull.
131. Poultry Science and Practice—by Waite (Issued to D. A. O. S. C., Bandarawela).
132. The Citrus Industry, Volume I—by Webber & Batchelor (Issued to Horticultural Officer).
133. Grain Crops—by H. K. Wilson.
134. Raising Livestock—by Peters & Deyoe.
135. Soil Conservation, an International Study—by FAO.
136. Using Salty Land—by H. Green.
137. Report on Yellow Leaf Tobacco Industry in Cyprus—by G. Corbett.
138. The Artificial Insemination of Cattle—by Hammond, Edwards *et al.*
139. Modern Pig Keeping—by Jacques, 10th Edition.
140. Manual of Duck Keeping—by C. Roscoe.
141. Farm Machinery and Equipment—by H. P. Smith.
142. Advances in Genetics, Vol. II—by Demerec.
143. Feeds and Feeding—by Morrisin, 21st Edition.
144. Soil Erosion and its Control—by Ayres (Issued to D. A. O. S. C., Bandarawela).
145. Sui Principi Scientifici delle Lavorazione del Tabacco—by Prof. L. Bernadini.
146. Statistical Methods—by Snedecor, 4th Edition (Issued to Veterinary Research Officer).
147. Laboratory Exercises and Self Study Outline in General Bacteriology—by C. I. Nelson (Issued to Veterinary Research Officer).
148. Animal Castration—by G. R. White, 3rd Edition (Issued to Veterinary Research Officer).
149. What Dog is That ?—by Blyth & Kane (Issued to Veterinary Research Officer).

PERIODICALS

1. The Advancement of Science.
2. Agriculture Abroad.
3. Agronomia Angolana.
4. American Society of Plant Physiologists—Bulletins.
5. Brazil Trade Journal.
6. British Veterinary Journal.
7. Bulletin IAI.
8. Ceylon Chamber of Commerce Annual Reports and Accounts.
9. Commonwealth Entomological Conference Reports.
10. Commonwealth Mycological Conference Reports.
11. Compost Bulletin.
12. Cotton et Fibres Tropicales.
13. The Countryman.
14. Cyprus Department of Agriculture Leaflets. (Educational Series).
15. Edinburgh and East of Scotland College of Agriculture Reports.
16. Essex Institute of Agriculture Annual Report
17. Essex Institute of Agriculture Calender and Prospectus.
18. Experimenta.
19. Flora Malesiana.
20. Forestry Abstracts.
21. Fort William District Experiments Sub-Station Progress Reports.
22. India and America.
23. Indian Newsfile.
24. Indian Literary Review.
25. Indian Sugar Industry Annual.
26. Insecticide Abstracts and News Summary.
27. Italian Trade News Bulletin.
28. Notas Agronomicas.
29. Phillipine University Bulletins.
30. Imperial College of Tropical Agriculture Trinidad Prospectus.
31. Puerto-Rico Report of the Federal Experiment Station.
32. Quarterly Bulletin of Agricultural Statistics.
33. Research and Farming.
34. Sciex Bulletin—Technical Series.
35. Suelo Tico.
36. Treubia.
37. United Asia.